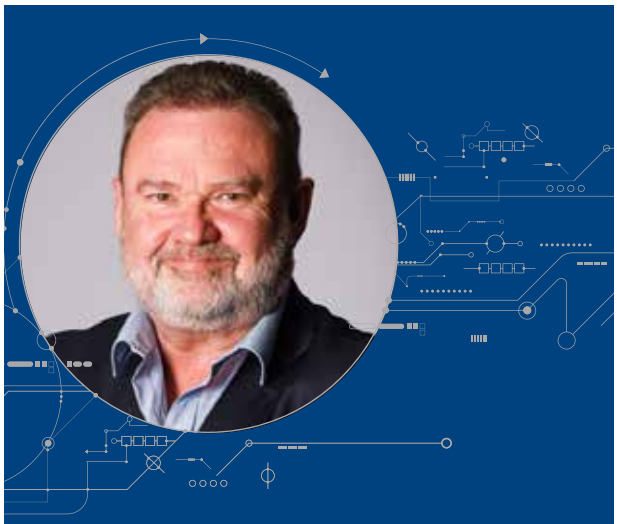
STRATEGIC PLAN 2020-2025

science & innovation

Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

technology innovation
A G E N C Y
Innovating Tomorrow Together

Foreword



As the Technology Innovation Agency (TIA) enters a new strategic planning cycle, it is important to reflect not only on the agency's successes, but the challenges it has faced since its establishment in 2009. We need to critically assess to what extent TIA, in fulfilling its mandate, enabled South Africa to traverse its socioeconomic challenges through technology and innovation.

TIA is mandated to translate a greater proportion of publicly-funded research into commercial technology products and services. This implies exploiting the existing body of knowledge at universities and public research organisations, and channelling it towards the development of technology-based industries. This is done with the intention of creating sustainable jobs and transforming the economy from one that is reliant on commodity exports to one that is knowledge-based and equipped to address modern local and global challenges.

During the previous strategic cycle, TIA invested in a range of initiatives and projects that saw 77[1] technologies brought to market, and contributed, on average, R3,10 to the South African economy for every R1 spent. Although this is commendable TIA will not be able to sustain or amplify this achievement unless it intensifies partnerships with other key stakeholders in the National System of Innovation. The necessity of increasing these partnerships is highlighted further when considering that the technology and innovation ecosystem has gained significant momentum in recent years.

South Africa is currently experiencing significant socio-economic challenges that require us to intensify our efforts and ensure that the country moves towards sustained economic growth in which the role of science, technology and innovation is enhanced. The challenges facing South Africa today, in particular the triple challenges of poverty, unemployment and inequality, have come to the fore more glaringly as we look back at our achievements since 1994. As we enter the sixth administration, these challenges, along with the imperatives of transformation and economic inclusiveness, have become the centre point around which government, business and all stakeholders have come to rally, as we plan into the future.

The global economy is experiencing a significant downturn, placing the realisation of the sustainable development goals and responses to the challenges of climate change at risk. Across the world, countries are looking for ways to harness science, technology and innovation to address these challenges. South Africa is no different, and the adoption of the White Paper on Science, Technology and Innovation in 2019 represents an important policy development that elevates the discourse around science, technology and innovation to respond to our national and global challenges. The White Paper places innovation at the core of all efforts to shift South Africa into a new growth and development

[1] *Includes estimation for 2019/20.*

trajectory. Most importantly, it introduces important dimensions of inclusivity, transformation, and society-wide and government-wide approaches to innovation.

Going forward, TIA's strategy, which is primarily informed by its mandate, is aimed at supporting the strategic intents of the White Paper on Science, Technology and Innovation, the National Development Plan and other key government policies. For this purpose, TIA's five-year strategy is predicated on three pillars:

- Intensifying efforts to accelerate the translation and **commercialisation** of publicly-funded research.
- Harnessing the opportunities presented by the **bio-economy** as an important area for future growth.
- Increasing and expanding access for innovators to convert their ideas into products and services through TIA's **Technology Stations** infrastructure.

Another priority is to support the development of viable technology enterprises that are able to compete in global markets, paying special attention to grassroots innovators as key contributors to the development of local economies.

The imperatives of transformation and inclusivity are paramount in implementing this strategy. Over the period ahead, TIA will place greater emphasis on the empowerment of youth, women and people with disabilities to ensure that they benefit from innovation and are included as important actors in the production of innovative solutions to address South Africa's socioeconomic challenges. The 2013 Ministerial Review of TIA highlighted the need for the agency to serve as a hub that facilitates effective interactions among actors in the National System of Innovation. This places TIA in the key role of risk funder to, in turn, attract other investors to take projects to market. Although TIA has made some strides in effecting change in the National System of Innovation, much remains to be done. Many of the recommendations from the Ministerial Review remain relevant and will continue to inspire TIA's efforts in the future.

I have no doubt that TIA has turned the corner. Through a continuous process of self-reflection and interactions with stakeholders, the agency will continue to explore ways of adapting and responding to the challenges of the day. This Strategic Plan, therefore, constitutes the foundational script on which TIA will aim to mobilise its partners and stakeholders, and work to make a meaningful impact in addressing South Africa's challenges. As such, the 2020-2025 strategic planning process has benefited tremendously from the collective wisdom of key role players in the National System of Innovation.

In this regard, I would like to thank the Minister of Higher Education, Science and Innovation, Dr Bonginkosi Nzimande; the Director-General of the Department of Science and Innovation, Dr Phil Mjwara and his senior management; and our stakeholders and partners for their constant, consistent and honest input and feedback. I would also like to thank the Board of TIA, management and staff for their commitment and active engagement in developing this strategy. We look forward to this next important phase in TIA's existence.

Dr Stephen Lennon
Interim Chairman of the Board

Official sign-off

It is hereby certified that this Strategic Plan:

- Was developed by TIA's management under the guidance of the Board and the Department of Science and Innovation (DSI).
- Takes into account all the relevant policies, legislation and other mandates for which TIA is responsible.
- Accurately reflects the impact, outcome and outputs that TIA will endeavour to achieve over the period 2020-2025.

Signed by:

Mohohlo Molatudi
Acting General Manager: Bio-economy division
Signature: _____

Elijah Mokhethi
Acting General Manager: Sector Funding division
Signature: _____

Dr Anitha Ramsuran
Acting General Manager: Programmes division
Signature: _____

Petro Dekker
Executive: Corporate Services
Signature: _____

Patrick Krappie
Executive Manager: Strategic Engagements and Corporate Relations
Signature: _____

Werner van der Merwe
Chief Financial Officer
Signature: _____

Fuzlin Levy-Hassen
Interim Chief Executive Officer
Signature: _____

Dr Steven Lennon
Interim Chairman of the Board
Signature: _____

Approved by:

Minister Bonginkosi Nzimande
Executive Authority
Signature: _____

Contents

PART A:
MANDATE

1. Constitutional mandate

Not applicable.

2. Legislative mandate

TIA was established as a schedule 3A[2] public entity in terms of the Public Finance Management Act (Act 29 of 1999, as amended). Its mandate is derived from the provisions of the Technology Innovation Agency Act (Act 26 of 2008), read together with sections 19-23 of the Science and Technology Laws Amendment Act (Act 7 of 2014) which establishes TIA as an agency to promote the development and exploitation, in the public interest, of discoveries, inventions, innovations and improvements. TIA's objective is to support the state in stimulating and intensifying technological innovation to improve economic growth and quality of life for all South Africans by developing and exploiting technological innovations.

3. Policy Mandates

United Nations sustainable development goals

The United Nations sustainable development goals seek to end poverty and hunger globally; combat inequality within and among countries; build peaceful, just and inclusive societies; protect human rights; promote gender equality and the empowerment of women and girls; and ensure the lasting protection of the planet and its natural resources. Countries committed to the goals aim to create conditions for sustainable, inclusive and sustained economic growth, shared prosperity and decent work for all, considering different levels of national development and capacities. The goals are integrated and indivisible, and balance the three dimensions of sustainable development – economic, social and environmental. There are 17 goals planned for completion by 2030, and 169 targets that demonstrate the scale and ambition of the new universal agenda.

Over the five-year period, TIA aims to contribute to the realisation of many of these goals by stimulating industry and the broader economy through the directed funding of innovation and commercialisation. This will entail a focus on accelerating the translation of indigenous knowledge outputs into products and services that contribute to redressing socioeconomic vulnerabilities in marginalised communities in South Africa while ensuring increased inclusivity to encourage the participation of women, youth and people with disabilities. Focus will also be placed on the conservation of the country's natural resources.

African Union Agenda 2063

A 10-year Science, Technology and Innovation Strategy for Africa was adopted at the 23rd Ordinary Session of African Union Heads of State and Government in 2014. The strategy, which promotes competitiveness through human capital development, innovation and value-addition, is part of the African Union's long-term, people-centred Agenda 2063, a strategic framework for the socioeconomic transformation of Africa over the next 50 years. It builds on and seeks to accelerate the implementation of past and existing continental initiatives for growth and sustainable development. This is underpinned by science, technology and innovation as multifunctional tools and enablers for achieving development goals on the continent. Agenda 2063 calls for diversifying sources of growth for Africa's economic performance and, over the long term, lifting large sections of the continent's population out of poverty. The strategy also fosters social transformation, economic industrialisation and entrepreneurship. TIA plans to increase collaboration with research institutions across the continent through the implementation of joint technology development programmes and the provision of technical competence and entrepreneurial capacity development to increase the application of knowledge outputs in stimulating socioeconomic transformation.

National Development Plan 2030

The National Development Plan recognises that developments in science, technology and innovation fundamentally alters the way people live, communicate

[2] *Schedule 3A entities are public entities that have the mandate to fulfil a specific economic or social government responsibility.*

and transact. The plan highlights that these areas are key to equitable growth and underpin economic advancement, and improvement in health systems, education and infrastructure. The plan is now in its second phase, during which "the country should lay the foundations for more intensive improvements in productivity".

2019-2024 Medium-Term Strategic Framework

Government's 2019-2024 Medium-Term Strategic Framework serves as the implementation plan for the second phase of the National Development Plan. The framework identifies seven priorities to guide planning by all stakeholders. These are:

Priority 1: A capable, ethical and developmental state
Priority 2: Economic transformation and job creation
Priority 3: Education, skills and health
Priority 4: Consolidating the social wage through reliable and quality basic services
Priority 5: Spatial development, human settlements and local government
Priority 6: Social cohesion and safe communities
Priority 7: A better Africa and world

The DSI has committed to priorities 2 and 3, excluding job creation *per se*. Through its mandate, TIA will contribute to these priorities through the commercialisation of intellectual property from publicly funded research institutions, and support the creation of technology enterprises that will contribute to job creation with a specific emphasis on historically disadvantaged individuals and communities.

National Spatial Development Framework 2050

The National Spatial Development Framework 2050 sets out national spatial directives for all forms of infrastructure investment and developmental spending targeted by government in partnership with the private sector. In realising this, one of the key thrusts of the plan is "technology, innovation, resilience and disruptions in the space economy", through which South Africa will roll out fast broadband access across the country; support the development of highly automated mining activities; promote automation in key economic sectors such as manufacturing and agriculture; and accelerate the closure of factories and mines that are unable to compete globally. TIA will increase the footprint of its innovation infrastructure to contribute to the plan's aspirations of "a focus on innovation and knowledge generation, packaging and sale, expansion, modernisation and re-gearing of the higher education sector towards growing and supporting innovation" over the medium term by ensuring that the interventions it undertakes lead to inclusive localised development.

White Paper on Science, Technology and Innovation

Cabinet's adoption of the White Paper on Science, Technology and Innovation in March 2019 signals material policy shifts for activities related to science, technology and innovation to address aspects such as transformation and inclusivity, and strong linkages within the National System of Innovation. These include: strengthening the culture of innovation within government and society; improving policy coherence and more effective budget and programme coordination within the National System of Innovation; implementing monitoring and evaluation systems; creating a more enabling environment that advances innovation; developing local innovation ecosystems; and increasing investment in technology-based small, medium and micro enterprises and support to grassroots and social innovation projects.

DSI Decadal Plan

The process to compile the new DSI Decadal Plan, which will serve as the implementation plan for the White Paper on Science, Technology and Innovation, is ongoing. TIA will align itself with the plan once its finalised. The DSI has identified the following priorities with direct relevance to TIA's mandate, wherein plans at subprogramme level have been identified to realise the intended outcomes:

- The circular economy.
- Education for the future.
- Sustainable energy technologies for marginalised people.
- Health technology to prevent and treat ill-health and advance wellbeing for those who are marginalised.
- High-tech industrialisation.
- Opportunities, threats and impact of information and communications technology, including smart systems.
- Nutrition security for a healthy population.
- Integrated solutions for water security.

Alignment with DSI research and development roadmaps

Over the years, the DSI has developed several research, development and innovation roadmaps. These serve as key national frameworks to guide and direct investment decisions for research and development, and collaboration among various stakeholders in the National System of Innovation. In implementing its activities under the various subprogrammes, TIA will continue to be informed by these roadmaps, which include advanced manufacturing, information and communications technology, human settlements, water and waste management, and research infrastructure. Over the strategic period, TIA will work closely with the DSI to ensure that there is greater alignment with and translation of planned outputs to better inform decision-making and policy formulation.

Bio-economy Strategy

The Bio-economy Strategy seeks to use South Africa's bio-based resources to become a significant contributor to the country's economy by 2030 through the creation and growth of biotechnology-based industries. In turn, these new industries will generate and develop bio-based services, products and innovations in which new and existing companies will provide and use such solutions. The strategy provides a framework for investments and action by all relevant stakeholders in the National System of Innovation. As the effective implementation of the Bio-economy Strategy forms one of the four strategic outcomes for TIA in the current planning cycle, it will be implemented with greater intensity. Over the five-year strategic period, TIA intends to place a renewed and deliberate emphasis on indigenous knowledge systems as a key basis for promoting economic inclusion and transformation with great potential to lead to the creation of new industries.

District Coordination Service Delivery Model

In August 2019, Cabinet approved the District Development Model to synchronise planning by all spheres of government at the national, provincial and local levels. This model will enable partnerships with civil society, including communities, private industry and labour, at district level countrywide in the development of South Africa's municipal districts and metros. This developmental initiative is termed *"khawuleza"* ("hurry up").

Government will seek to change the face of rural and urban landscapes by ensuring greater alignment between urban and rural development, with a deliberate emphasis on local economic development. The district-driven model is directed at turning plans into action, and ensuring proper project management and tracking. Shortcomings in previous service delivery models necessitated a new, more practical, achievable, implementable and measurable approach to development that is clearly aligned with the key government priorities.

The model will be implemented over a five-year period commencing in 2020/21, and will be rolled out throughout all 44 districts and eight Metros.

TIA's contribution to the DSI's outcomes

Outcome	Goal statement	Proxy indicator aspects	TIA's contribution
A transformed, inclusive, responsive and coherent National System of Innovation	Expand, transform and enhance the responsiveness of the National System of Innovation over the next five years	Formalised partnerships between constituent parts of the National System of Innovation	Collaborate with other National System of Innovation stakeholders in developing technological innovations through leveraged funds and other resources. This includes partnerships with higher education institutions (including technical and vocational education and training colleges) and science councils
		Gross expenditure on research and development as a proportion of GDP of 1,1%	
Knowledge utilisation for economic development in revitalising existing industries and spurring research and development-led industrial development	Improve the sustainability and competitiveness of traditional sectors and emerging sectors over the next five years	Sectoral master plans with science, technology and innovation components developed and implemented	Implement sector master plans by investing in emerging and advanced technologies to enhance the competitiveness of TIA-funded innovations
		Improve the performance of small, medium and micro enterprises and opportunity gains through technology interventions	Provide financial and non-financial support to small, medium and micro enterprises to take advantage of market opportunities
Human capabilities and skills for the economy and for development	Improve the representability of high-end skills, and increase the development of technical and vocational skills for the economy over the next five years	Innovation engagement and awareness	Promote and encourage participation in the technology innovation value chain by historically disadvantaged institutions Support small, medium and micro enterprises

Outcome	Goal statement	Proxy indicator aspects	TIA's contribution
Increased knowledge generation and innovation output	Increase the relative contribution of South African researchers and science, technology and innovation institutions to global scientific and innovation output over the next five years	Prototypes	Increase the number of prototypes developed through TIA interventions
		Technology products and/or services commercialised	Increase the number of commercialised technologies, prototypes and demonstrators
		Translation rate between publicly financed intellectual property disclosure and licensing rate	
The use of knowledge for inclusive development	Expand the use of scientific knowledge (as evidence) in support of innovation for societal benefit and public good over the next five years	Locally developed technology deployment across the three spheres of government	Number of technology demonstrations and locally developed technology deployment to districts and local municipalities
		Funding instruments for grassroots innovation	Support package for grassroots innovation
		Publicly financed intellectual property made available in support of grassroots innovators	Open innovation platform for grassroots innovators

4. Relevant court rulings

Not applicable.

PART B:
STRATEGIC FOCUS

1. Vision, Mission and Values

Vision:

Be a leading technology innovation agency that stimulates and supports technological innovation to improve quality of life for all South Africans.

Mission:

Facilitate the translation of South Africa's knowledge resources into sustainable socioeconomic opportunities.

Values:

TEAMWORK	**Together we can do more.** Fostering teamwork creates a TIA work culture that values collaboration and co-operation.
PROFESSIONALISM	At TIA we apply the most appropriate skills, competencies, experience and knowledge of best practices cohesively in conducting our work.
EXCELLENCE	TIA will be accountable to all stakeholders to deliver exceptionally high standards of work and performance.
INTEGRITY	At TIA everyone strives to do what they said they would. **"We keep our word".**
TRANSPARENCY	Engage in inclusive open communication, hold each other accountable for our performance and conduct.
INNOVATION	At TIA we foster a culture where we continually nurture and implement new ideas from our staff and stakeholders that enhance how we do things and deliver services.

2. Strategic Overview

TIA enters the new strategic cycle against the backdrop of an ecosystem that is rapidly maturing, characterised by the entry of many players in the National System of Innovation. These include institutional and private funders, an expanded research base, an active technology entrepreneurship community and support intermediaries. In crafting its new strategy, TIA has taken into account these developments, identifying gaps that require targeted interventions within the agency's mandate to avoid the duplication of efforts and focusing on areas where it adds value to the functioning of the National System of Innovation.

According to the agency's Business Case[3], "TIA has been set up as a public entity that enhances the country's capacity to translate a greater proportion of local research and development into commercial technology products and services. For this purpose, the agency has been tasked with exploiting the existing body of knowledge at universities and public research institutions and channelling it effectively towards the development of technology-based industries."

To carry out its mandate, TIA requires both formalised partnerships with universities and public research institutions and other government instruments such as those of the Department of Trade, Industry and Competition. This ensures connectedness along the innovation value chain, which is critical to allow for the nurturing of technologies from laboratory to market. The ultimate goal is to use South Africa's science and technology base to develop new industries, create sustainable jobs and help diversify the economy away from commodity exports towards knowledge-based industries equipped to address modern global challenges.

In 2013, the DSI undertook an assessment of TIA's performance against its mandate and positioning within the National System of Innovation. Based on this, the Ministerial Review Report[4] highlighted a number of key areas that require attention if TIA is to fulfil its mandate effectively and contribute to building a productive ecosystem.

Key among these are that TIA:

- serves as a "hub" where entities such as publicly funded research institutions, large and small commercial and industrial businesses, innovative private individuals, non-governmental organisations and community-based organisations, and technological innovation support instruments funded by government departments and public and private entities would interface with the objective of converting ideas into commercial activities.
- assumes the fundamental role of a publicly funded instrument that ensures a national innovation ecosystem functioning at maximum efficiency and effectiveness, and an interface for the conversion of ideas into commercial activities.
- effectively plays its role as a grant-making agency and approaches the accrual of return on investment not in terms of balance sheet, but rather benefits to the national economy from commercialised innovations (eg. jobs).
- enhances its ability to support small, medium and micro enterprises through an appropriately positioned and scaled-up Technology Stations Programme.
- implements an effective regionalisation strategy.
- improves operational efficiencies and its reputation, especially in relation to turnaround times for enquiries, applications, progress payments, overhead costs and communication with stakeholders.
- promotes a culture of innovation that enhances the role of people as innovators through events that highlight role models, and supports the integration of entrepreneurship into the education system.

Over the past five years, TIA has made progress in repositioning the Technology Stations Programme to provide much-needed science, technology and engineering support to more than 10 000 small, medium and micro enterprises through access to high-end innovation infrastructure and expert technical advice. In addition, TIA has played an important role as a connector and enabler, promoting interactions among various stakeholders through strategically selected events. These include the Innovation Bridge, the Bio Africa Convention and the Global Cleantech Awards, all of which have served as effective platforms to promote matchmaking and showcase South Africa's innovations, thereby promoting

[3] *TIA Business Case (2008).*

[4] *TIA Review Report (2013).*

role models in innovation. In line with the recommendations of the TIA Review Report, the agency has endeavoured to focus on return on investment that emphasises broad socioeconomic impact.

On the other hand, TIA has not been successful in expanding its national footprint, primarily due to financial constraints. Nevertheless, there are opportunities to explore the more effective use of Technology Station facilities and other co-location models with partners in the National System of Innovation to reach the underserved parts of the country.

A critical review of TIA's execution of its core mandate reveals that in the past five years the agency has supported a large number of innovations. However, the translation and commercialisation success rate has been suboptimal. As a result, TIA aims to reposition itself strategically within the National System of Innovation, directing a greater proportion of its resources towards the translation and commercialisation of publicly financed intellectual property emanating from higher education institutions and science councils.

TIA's strategy is based on three pillars, as depicted in Figure 1.

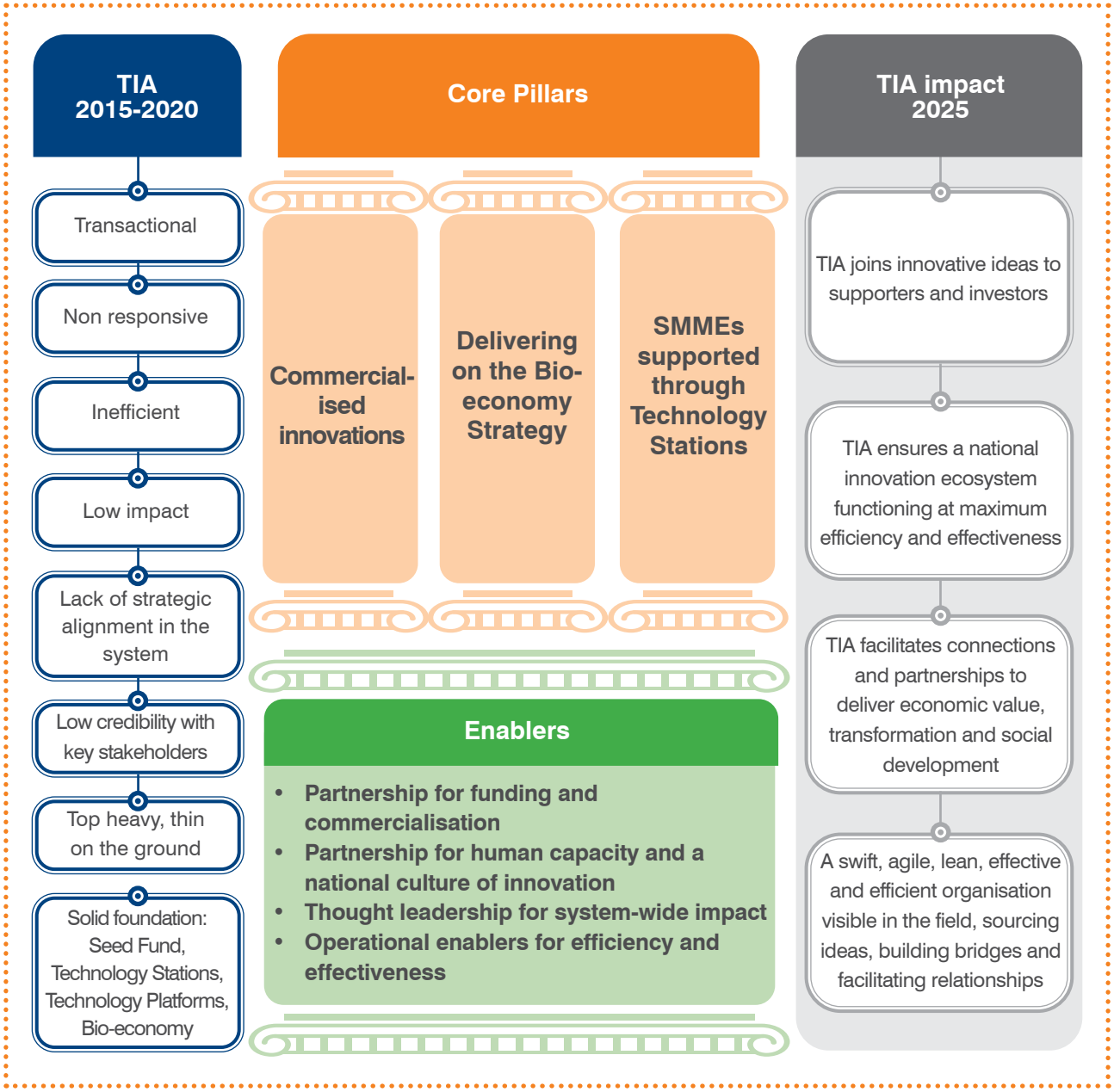


Figure 1. TIA's strategic focus for the 2020-2025 strategic period

i. Commercialising innovations

Through this strategic thrust, TIA will intensify efforts to increase the rate of translation of locally developed technologies; exploit intellectual property from publicly funded institutions; ensure that these are commercialised in a manner that promotes economic growth and the competitiveness of industry; and respond to the imperatives of transformation and inclusive development. TIA will focus on leveraging local and global partnerships to support the translation of knowledge from higher education institutions, science councils and the private sector into commercialised innovations that will have a positive impact on the lives of all South Africans. TIA will also take advantage of the fourth industrial revolution to stimulate the economy and address some of the social challenges faced by many South Africans.

ii. Delivering on the Bio-economy Strategy

Through this focus area, TIA's efforts will be directed towards creating new bio-based products and processes and promote the creation of new enterprises that will ultimately lead to job creation. In doing so, TIA will increase its efforts to grow and enhance the role of indigenous knowledge systems as an important sector with great potential for inclusive development and transformation.

iii. Small, medium and micro enterprises supported through strategically informed and regionally distributed Technology Stations

The changing innovation landscape requires that TIA positions its Technology Station capabilities as part of a package of support in the National System of Innovation to promote the growth of collectives and small, medium and micro enterprises; contribute towards innovation-led industrialisation processes; and foster inclusive development through an expanded spatial footprint and enhanced access for entrepreneurs throughout the country.

3. Situational analysis

Transformation in TIA's operating environment has been slow, despite government's deliberate efforts. It is important to note that modern challenges of economic development require that science, technology and innovation are harnessed effectively as key policy instruments to accelerate economic growth and development. In this, TIA has an important role to play.

SWOT analysis

During the strategy development session, the Board deliberated on the operating landscape for the upcoming strategic cycle. In seeking to identify TIA's internal strengths and weaknesses, and its external opportunities and threats, a diagnostic assessment was undertaken using a strengths, weaknesses, opportunities and threats analysis, the results of which are presented below.

Strengths	Weaknesses
- The uniqueness and extent of TIA's mandate positions it as a relevant institutional intervention in the National System of Innovation - Solid foundation with key instruments such as the Seed Fund Programme, Technology Stations Programme and Technology Platforms Programme - Solid pipeline of near-market technologies for greater impact in the future - Good baseline of sound strategic partnerships - Unique innovation funding instruments - Sound governance and control environment	- Top heavy, thin on the ground - Lack of ecosystem/multi-stakeholder project funding - Operational inefficiencies related to poor turnaround times and lack of communication - Lack of strategic alignment in the National System of Innovation - Low credibility with key stakeholders
Opportunities	**Threats**
- New policy thrusts arising from government's 2019-2024 Medium-Term Strategic Framework, the White Paper on Science, Technology and Innovation, and the DSI Decadal Plan, as well as an emphasis on transformation and inclusivity, provide a good context and an opportunity for TIA to fully deploy its mandate - Positive momentum around innovation, especially with industry partners, presents opportunities to increase the rate of commercialisation for demand-driven approaches to innovation - TIA has established a significant relationship with the SA SME Fund, which presents opportunities to tap into its pool of partnerships with other players and fund managers in South Africa - TIA will have to leverage on its mandate to make a real contribution within the fourth industrial revolution discourse through investments in big data, blockchain and artificial intelligence technologies - Managing sector programmes on behalf of the DSI	- Reducing fiscal allocation - Weak economy - Lack of confidence in TIA - Other players/competitors encroaching on TIA activities

An analysis of TIA's performance over the past five years reveals that approaches to project sourcing and identification have not been optimal. This is largely due to lack of clearly defined strategic priorities, and a lack of alignment with market demands, government priorities and general dynamics in the ecosystem. As a result, TIA has not been effective in attracting fundable proposals that can progress rapidly to market and have the potential for real socioeconomic impact. Although the Seed Fund Programme has proved to be an important instrument for sourcing innovations and ideas from universities and small, medium and micro enterprises, much of the pipeline from this instrument has not progressed into TIA's main funds, primarily owing to misaligned requirements, inadequate assessment criteria and weak internal coordination.

Nevertheless, South Africa's innovation ecosystem has matured over the past few years, with many players having the potential to accelerate TIA's execution of its mandate. However, the ecosystem remains fragmented, with many of these players undertaking initiatives that are not properly coordinated for maximum impact. In response to this, the White Paper on Science, Technology and Innovation identified partnering and co-creation as a major strategic intent. In this regard, TIA has a key role to play in continuing and intensifying the implementation of a transparent partnership model (referred to as the "Glass Pipeline" in TIA parlance) to provide a bird's eye view of the system and facilitate the seamless progression of innovations through the value chain.

In reality, however, TIA remains underfunded, with an average annual budget of R500 million that largely supports the Bio-economy Programme and Technology Stations Programme. The implication of this is that there is a relatively small amount of funding available for meaningful investments in new projects. As the tight economic conditions in South Africa suggest that there will be few prospects for new or additional funds over the medium term, TIA will formulate a new approach to project support that focuses on partnerships, the strategic sourcing of projects and an ecosystem with a multi-stakeholder approach to investments.

4. External environment analysis

Knowledge generation, intellectual property and commercial outputs

TIA depends on the outputs of research conducted at higher education institutions, science councils and other research institutions for its pipeline of early-stage investable projects. The agency supports these through to higher levels of maturity so that they are sufficiently de-risked to attract other funders such as venture capital investors. South Africa possesses strong knowledge-generation capacity and good research infrastructure within publicly funded organisations. The Offices of Technology Transfer at publicly funded research organisations are an important source of new knowledge and intellectual property with the potential to be commercialised. As such, Offices of Technology Transfer are key sources of investment pipeline for TIA.

The National Advisory Council on Innovation, in its 2019 Science, Technology Innovation Indicators report, reveals key insights into the performance of the research system and the associated spending by government and business, as follows.

- Government funding of research and development for the higher education sector increased from 45% in 2010/11 to 56,1% in 2016/17.
- The share of total research and development funding from government directed towards science councils decreased from 33,7% in 2010/11 to 30,9% in 2016/17. Over the same period, however, science councils received a significant increase in funding, from R2,9 billion in 2010/11 to R5,1 billion in 2016/17.
- The higher education sector increased its role in the South African innovation system between 2007 and 2017, as indicated by the significant increase in the proportion of basic research, from 20,6% in 2007/08 to 26,7% in 2016/17.
- The share of South Africa's scientific publications as part of the top 1% worldwide increased from 1,1% in 2007 to 1,6% in 2017, demonstrating the success of the higher education sector in producing high-quality scientific publications.

The National Advisory Council on Innovation's 2017 Science, Technology and Innovation Indicators report revealed that, as of 2017, universities of technology account for only 4,8% of the total research publications compared to 80,4% published by the other universities.

In contrast, the proportion of research and development devoted to experimental development has decreased significantly over the years, as shown in Figure 2, which appears in the 2019 State of the South African Research Enterprise report. A decrease in experimental development against an increase in basic research and applied research (collectively 74,5% of measured research and development spend) means that there is an increase in the generation of scientific knowledge, and a decrease in the number of technologies being developed, the number of new and improved products and services being produced, and the amount of technological knowledge being generated. More innovative economies and those enjoying greater growth rates devote a greater proportion of expenditure towards experimental development than basic and applied research combined.

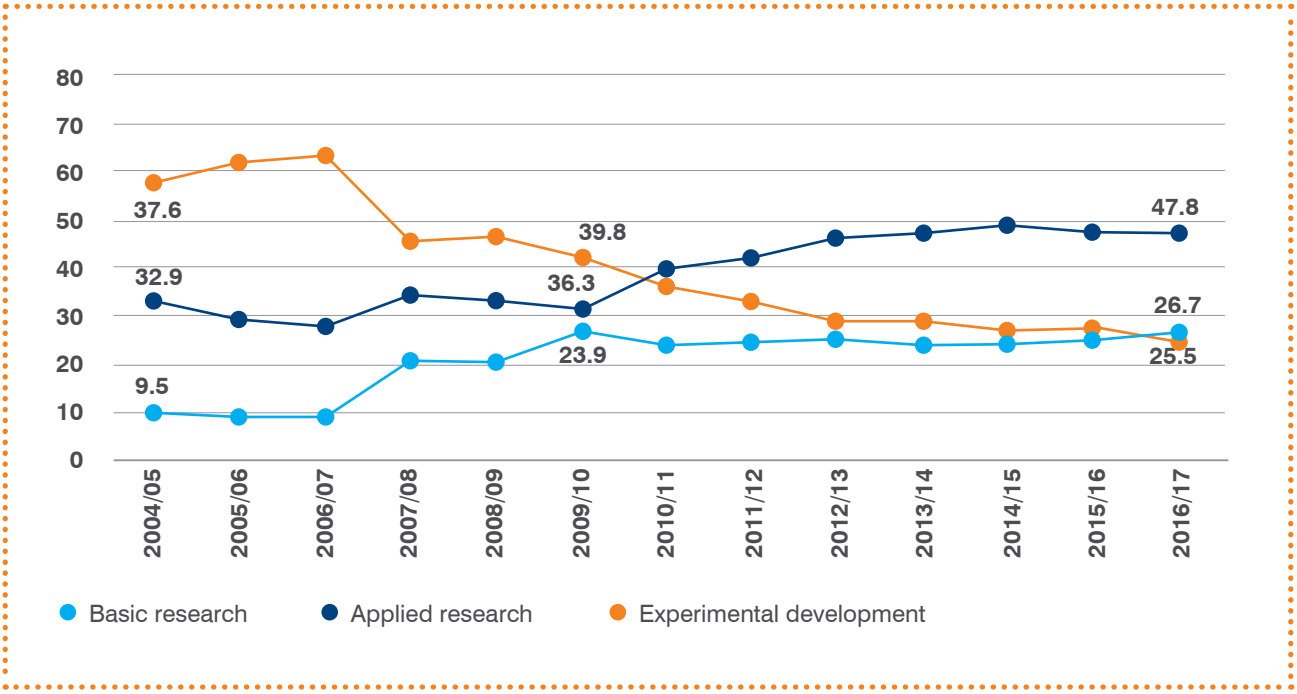


Figure 2. Trends in research and development expenditure (2004/05-2016/17)

All types of research and development are important, but given South Africa's state of development, there should be an increase in the proportion of the country's research and development expenditure going to experimental development.

In the period 2007-2017 government funding of business expenditure on research and development reduced significantly from 21,7% to 3,1%. Business expenditure on research and development, as a percentage of gross domestic product, decreased from 0,6% in 2007 to 0,4% in 2017.

Fewer researchers in South Africa are employed by the business sector compared to other upper middle-income countries. (Middle-income countries: 43,2%, South Africa: 37%). During the same period, there was a migration of researchers from the private sector to higher education institutions.

The National Advisory Council on Innovation report draws the conclusion that South African business enterprises need to take on proportionately more researchers or create new businesses that are research intensive. In the absence of such a trend, government instruments such as the Technology and Human Resources for Industry Programme and the Sector Innovation Fund have become important in enabling the industrial sectors to fulfil this objective.

Intellectual property rights: Patents

The production of South African patents is decreasing, and this trend is expected to continue beyond 2020. The low level of invention in South Africa is a serious policy issue that needs urgent attention. Through legislation, the National Intellectual Property Management Office is required to provide incentives to recipients and the creators of intellectual property to reward them for proactively securing intellectual property protection and commercialising it for the general purpose of innovation. Such incentives can comprise up to 30% of institutions' revenue accruing from intellectual property. Patents can, however, compete with publications, and a balanced portfolio is ideal. A large share (87,6%) of patent publications relates to non-residents, a trend that is expected to continue beyond the medium term. In comparison to other upper middle-income countries, South African residents' share of patents was high, at 83,9% in 2017.

South African innovation funding landscape

The funding landscape for innovation in South Africa has matured over the past decade, with many actors in the National System of Innovation establishing various types of funds and funding instruments to support the innovation and commercialisation of technologies emanating from publicly funded research institutions, small, medium and micro enterprises, and entrepreneurs in general.

The funding landscape for innovation continues to be dominated by government incentives. These are provided mainly through the DSI and several incentive schemes of the Department of Trade, Industry and Competition, including the Technology and Human Resources for Industry Programme; the Support Programme for Industrial Innovation; and the Industrial Development Corporation's Technology Venture Capital Fund. Organisations such as the National Research Foundation and a range of science councils and universities have also established various types of funding instruments. Figure 3 shows the instruments available through government.

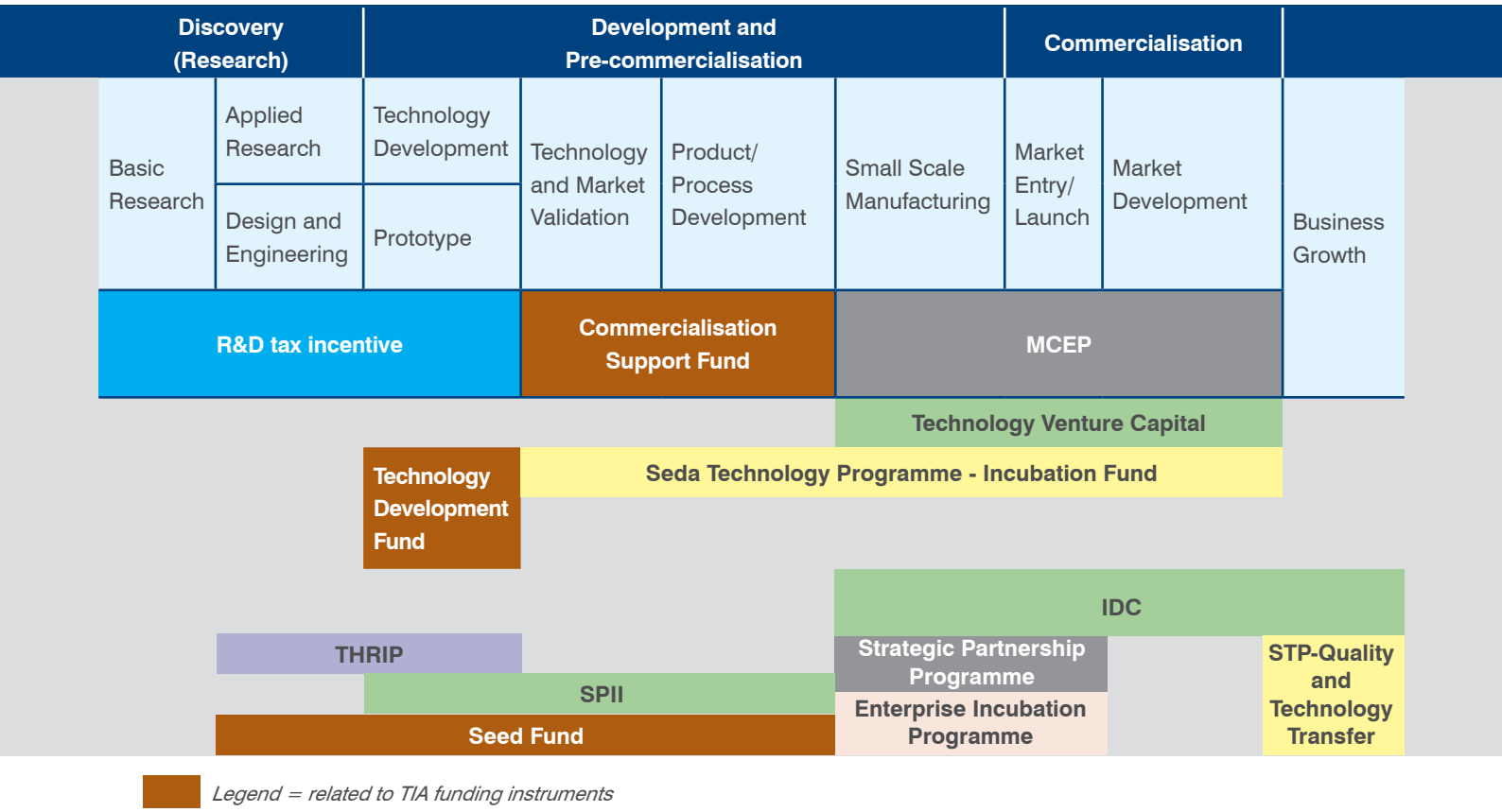


Figure 3. Government innovation and technology funding instruments (Source: Department of Trade, Industry and Competition)

TIA plays an important role within this funding ecosystem through unique risk-funding schemes such as the Seed Fund Programme, the Technology Development Fund and the Pre-Commercialisation Fund. The measure of success for TIA's risk-funding schemes is the extent to which they can support the progression of innovations to higher levels of maturity with minimised risk to attract follow-on funders such as venture capital to take them to market. In this role, evidence points to a mixed record of success. A key focus for TIA will be to consolidate its various funding instruments into one fund.

Technology and Human Resources for Industry Programme

The Technology and Human Resources for Industry Programme, funded by the Department of Trade, Industry and Competition, is designed to enable South African industry to access skills, expertise and infrastructure within the higher education sector to develop innovative solutions to industry-specific needs. Its aims are to boost South African industry through technology development while enhancing the development of skilled labour for absorption into local industries. Since its incorporation into the department,

the programme has been scaled up significantly, and its impact on various sectors of the economy and provinces throughout the country is beginning to become evident.

According to the Department of Trade, Industry and Competition's 2017/18 Annual Incentives Report, the programme significantly increased the total value of its grants from R158,2 million in 2016/17 to R235,4 million in 2017/18, and its portfolio of funded projects from 23 to 35 in key sectors such green energy, agro-processing, pharmaceuticals and manufacturing. However, a familiar challenge this programme faces is that it is dominated by projects in Gauteng, Western Cape and KwaZulu-Natal. TIA will actively promote the use of the programme's incentives, especially in cases where it facilitates technology development partnerships between large and small enterprises and publicly funded research institutions such as higher education institutions. TIA will identify opportunities and build on established initiatives that already exist in the programme, and seek to expand these provincially with identified local economic development partners.

Support Programme for Industrial Innovation

The Support Programme for Industrial Innovation is designed to promote technology development in local industries through the provision of financial assistance for projects that develop innovative products and/or processes. This is in support of government's priority to strengthen South Africa's global competitiveness through the development of new technologies. The programme accepts ideas at the proof of concept stage and support projects until they reach a stage at which a prototype is ready for production. The Annual Incentives Report further reveals that the fund increased its portfolio of investments from six in 2016/17 to 25 in 2017/19, and disbursements from R20,8 million to R36,3 million over the same period. TIA recognises the synergies that exist between its risk-funding instruments and the programme. Opportunities to share and promote the efficient allocation of resources will be pursued and realised over the strategic period.

Venture capital

The venture capital industry in South Africa is a nascent asset class that has come to play an important role in the commercialisation of technologies. Between 2013 and 2018, it realised significant growth, with the number of investments increasing from 27 to 181, and total investment increasing from R1,9 billion in 2015 to R5,4 billion in 2018. The Southern African Venture Capital and Private Equity Association's 2019 Venture Capital Survey report reveals that there was a marginal increase in the number of fund managers in 2018 due to new independent fund managers drawing on the section 12J tax incentive. The 2019 report reveals interesting insights for TIA, particularly that there is growing venture capital activity in South Africa, and the venture capital community is becoming increasingly less risk averse, investing in early-stage opportunities and start-up companies. This presents an opportunity for TIA to leverage partnerships with venture capital companies to enhance its commercialisation efforts.

In addition to the private venture capital sector, the Industrial Development Corporation manages the Technology Venture Capital Fund on behalf the Department of Trade, Industry and Competition as the only government venture capital instrument. As the fund focuses on fully developed, near-market technologies, the Industrial Development Corporation remains one of TIA's key development partners as its funds have helped carry technology enterprises beyond TIA's funding capacity.

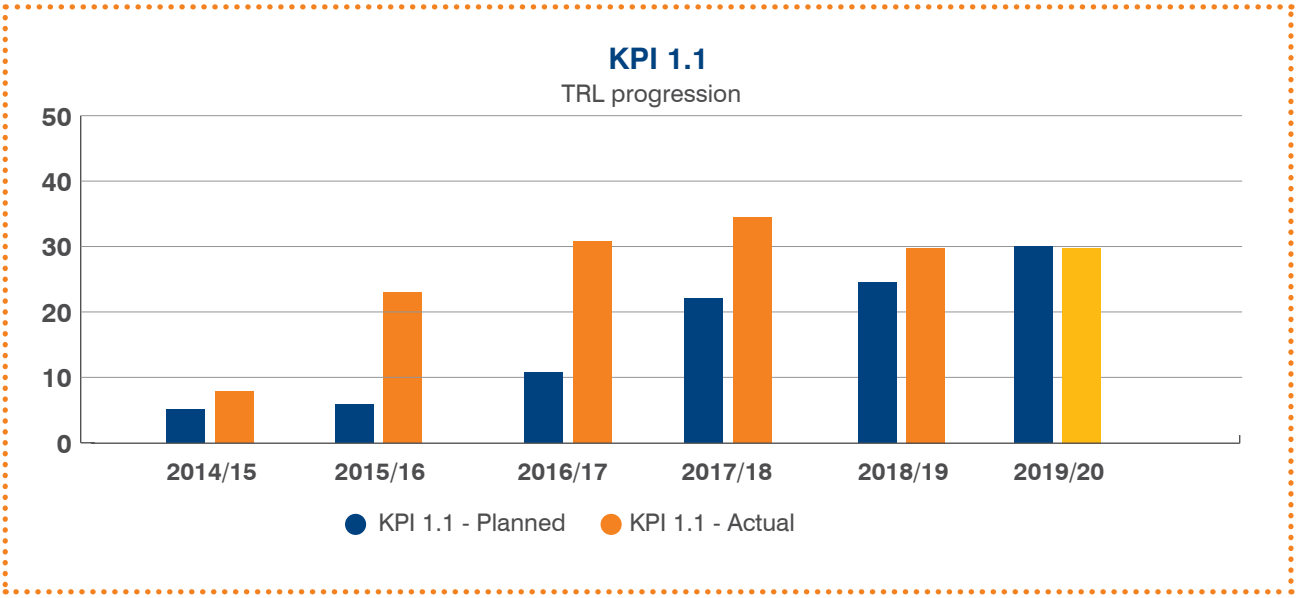
International funding

TIA plans to explore a number of international funding opportunities. These include institutions such as the Lemelson Foundation; the Bill & Melinda Gates Foundation; product-development entities such as the Foundation for Innovative New Diagnostics, the Programme for Appropriate Technology in Health, the Medicines for Malaria Venture and the Global Alliance for Tuberculosis Drug Development; and many initiatives in Europe and the United States concerned with identifying and preparing technologies that have the potential to result in commercially or socially viable products and high-potential companies. In the longer term, TIA plans to attract venture capital funding from firms interested in social investments in Africa in need of an agency to administer funds and manage investments.

5. Internal environment analysis

TIA's performance over the 2015-2020 strategic period

In pursuit of its mandate, during the 2015-2020 strategic period TIA supported 10 530 small, medium and micro enterprises through programmes such as the Technology Stations Programme and Technology Platforms Programme; supported 348 knowledge products; and recorded 296 technology innovations. During this period, TIA disbursed a total of R2,2 billion to support technology innovation and related infrastructure developments; and attracted R776 million into the portfolio, with more than 63 products and services commercialised. Figure 4 summarises TIA's performance in this period.



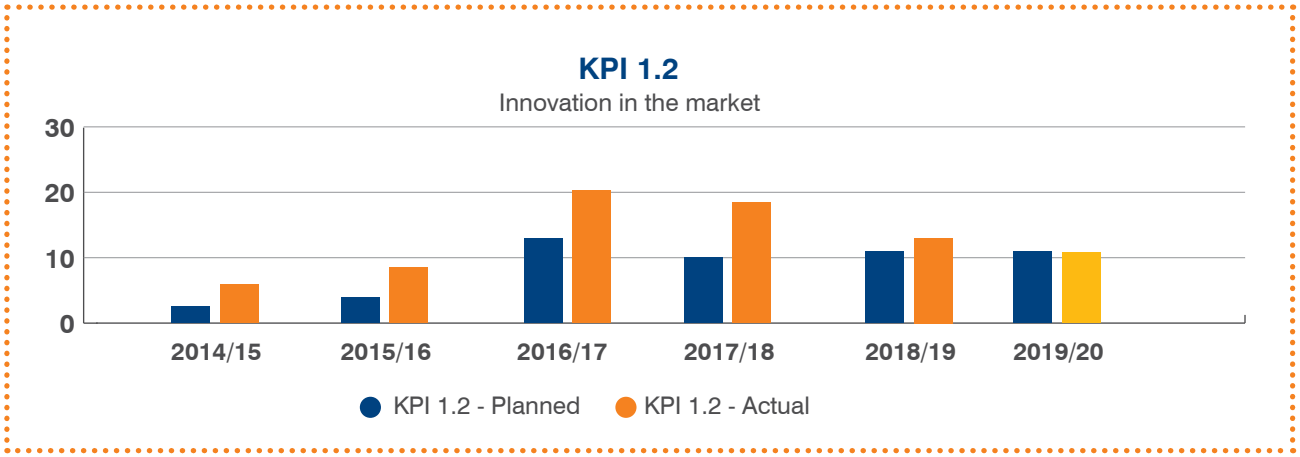


Figure 4. TIA's performance over the 2015-2020 strategic period (yellow bars depict projections for 2019/20)

Figure 4. TIA's performance over the 2015-2020 strategic period (yellow bars depict projections for 2019/20)

Economic impact

Each year, TIA commissions studies to assess the impact it has on the economy. TIA's disbursement of R2,2 billion through a combination of grant funding and enabling programmes to beneficiaries has contributed R7,5 billion to gross domestic product and created an estimated 18 536 jobs.[5] During this period, as depicted in Figure 5, TIA's average economic multiplier effect was R3,10 for every R1 spent. TIA's investees generated total revenue of R2,5 billion.[5]

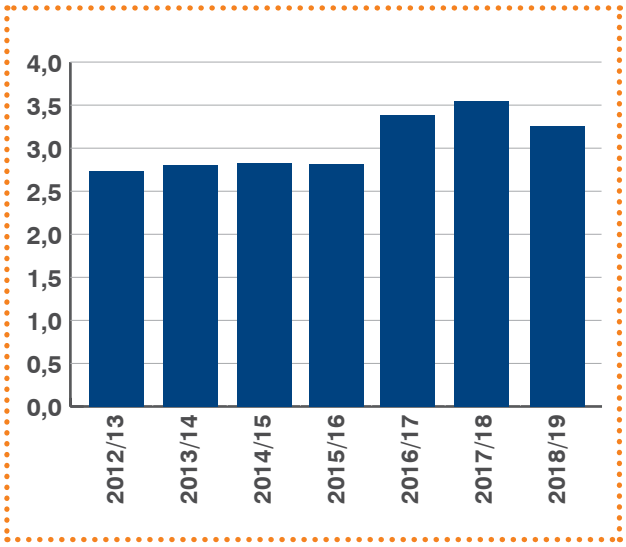


Figure 5. TIA's economic impact multiplier for the period 2012/13-2018/19

TIA's funding portfolio over the 2015-2020 strategic period

Over the previous five-year strategic period, TIA funded 185 projects to the cumulative amount of R1,1 billion. (This excludes the Seed Fund Programme). TIA has a contractual obligation to 160 ongoing projects, with 25 projects having been fully disbursed. A detailed analysis of TIA's portfolio reveals important insights that will inform the organisation's strategy into the future.

Figure 6 illustrates that TIA allocated 57% of its funding to higher education institutions and science councils during the 2015-2020 strategic period. The remaining 43% was split between small, medium and micro enterprises, large private companies and individual entrepreneurs.

[5]Contribution to gross domestic product, jobs created and investee revenue based on Social Accounting Matrix modelling.

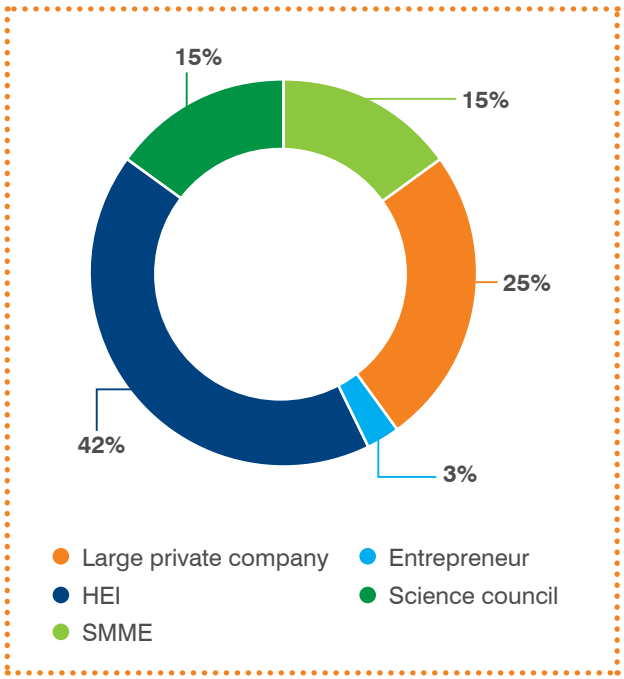


Figure 6: Allocation of TIA funds by market segment for the 2015-2020 strategic period

Figure 7 shows that TIA's expenditure was devoted primarily towards the bio-economy sector, comprising health, agriculture, industrial biotechnology and, to a lesser extent, indigenous knowledge systems. The natural resources portfolio includes mining, water, waste and sanitation.

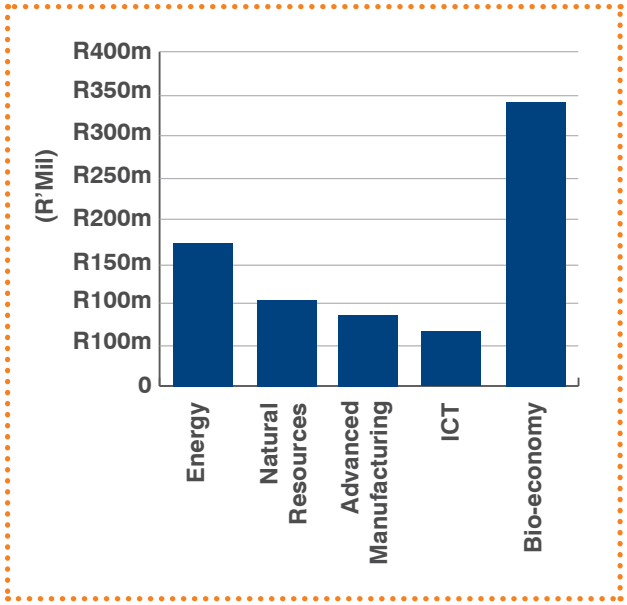


Figure 7. TIA's investment expenditure by sector for the 2015-2020 strategic period

As with many other development finance institutions in South Africa, TIA's investment portfolio exhibits a bias towards the major provinces of Gauteng, Western Cape and KwaZulu-Natal, primarily due to the high concentration of economic activity in the provinces driven by the presence of large metros. Figure 8 shows that an estimated 77% of funds were disbursed to recipients in Western Cape and Gauteng. Northern Cape and Mpumalanga each received only 0,1% of the allocation during this period.

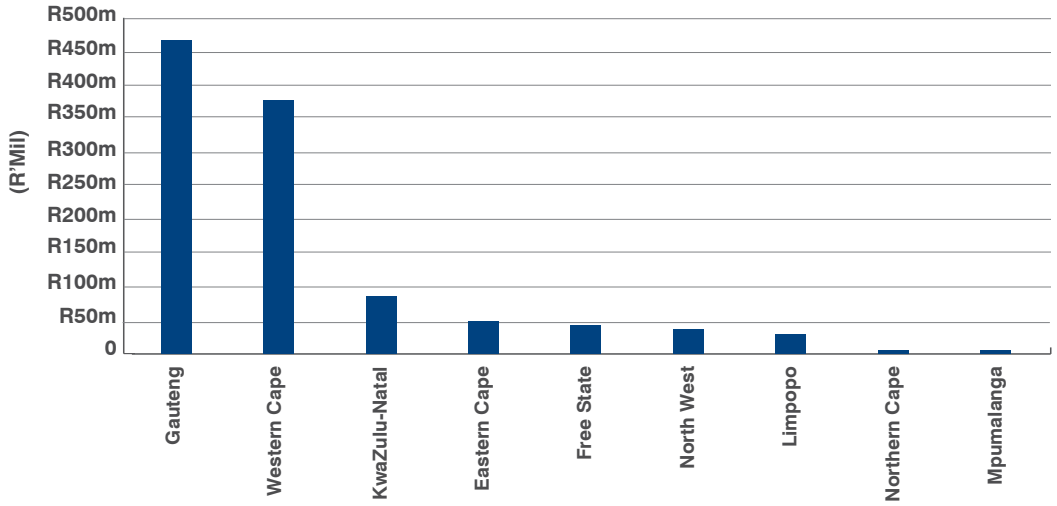


Figure 8. Funding allocation by province for the 2015-2020 strategic period

The insights from the analysis of TIA's portfolio are instructive for the agency's strategic direction. This is particularly important given South Africa's socioeconomic challenges and the key government policies that aim to address the triple challenges of poverty, inequality and unemployment. This direction will be guided by TIA's focus on contributing to priority 2 (economic transformation and job creation) and priority 3 (education, skills and health) of government's 2019-2024 Medium-Term Strategic Framework. In addition, the White Paper on Science, Technology and Innovation calls for a number of shifts that emphasise transformation, inclusivity and partnerships. The 2013 Ministerial Review Report will also continue to guide TIA's role and positioning in the National System of Innovation. The following principles will specifically guide TIA's strategy over the period ahead:

- Increase funding allocation towards the higher education institutions and science councils, and in so doing driving transformation and inclusivity, with a focus on historically disadvantaged institutions. In implementing this initiative, TIA will work closely with the National Intellectual Property Management Office to identify disclosed intellectual property for enhanced commercialisation.
- Although the sectoral split shows that TIA has prioritised certain sectors, the agency will align itself with key thematic areas to broaden its sectoral reach. This will result in greater alignment with the DSI's Decadal Plan, sectoral master plans and other key government policies aimed at addressing South Africa's socioeconomic challenges.
- Expand TIA's geographical footprint through increased support for underserved provinces in response to the imperatives of inclusive development and the empowerment of marginalised constituencies such as young people, women and people with disabilities. This will require increased investment in the priority sectors identified in the relevant provincial economic growth and development strategies in which TIA will also endeavour to broaden the deployment of services offered by Technology Stations.
- Accelerate the translation rate of ideas to high levels of maturity and use intellectual property from publicly funded research under appropriate conditions to

support women and black entrepreneurs when such intellectual property is commercialised. TIA will adopt an approach that emphasises demographic transformation, institutional transformation, and the transformation of the public's awareness of and value placed on science, technology and innovation.
- Increase engagement with the private sector, primarily with the aim of promoting collaboration with the research community; ensuring that TIA's research output is aligned with industry and sector needs; leveraging private sector funding and expertise; and promoting linkages with industry supply chains.

6. Planned strategic initiatives

Enhancing commercialisation

The commercialisation of promising ideas and innovations from publicly funded intellectual property remains at the core of TIA's mandate. Although the agency supported a range of innovations over the previous strategic period, the current socioeconomic context requires that TIA explores a variety of approaches to increase the rate at which it is able to accelerate early-stage ideas to higher levels of maturity, and thereby increase its commercialisation success rate.

Innovators have a range of options to consider when commercialising their technologies. These include licensing to potential customers, forging strategic alliances with customers to integrate technology into their supply chains, and whether to source equity investment through a spin-off company or an initial public offering. TIA has invested in many technologies that have followed these routes towards commercialisation. However, the success of innovations in which TIA has invested largely depends on the extent to which the agency is able to de-risk them.

Figure 9 shows the technology readiness level status for active projects in the Sector Funding division as at the fourth quarter of 2019/20. TIA will focus on commercialising projects that are between technology readiness levels 7 and 9. This portfolio consists of 22 near-market technologies that constitute an initial portfolio of projects that TIA will intensify its efforts to commercialise in the early years of the strategic cycle. Beyond this, TIA will adopt new development and funding strategies to enhance its commercialisation efforts, ensuring that it carefully selects and invests in projects based on the following approaches:

- The intensified deployment of a scaled-up Seed Fund Programme.
- An ecosystem approach to project funding.
- An approach led by industry demand that emphasises partnerships with the private sector.
- Joint technology development with African and international partners.

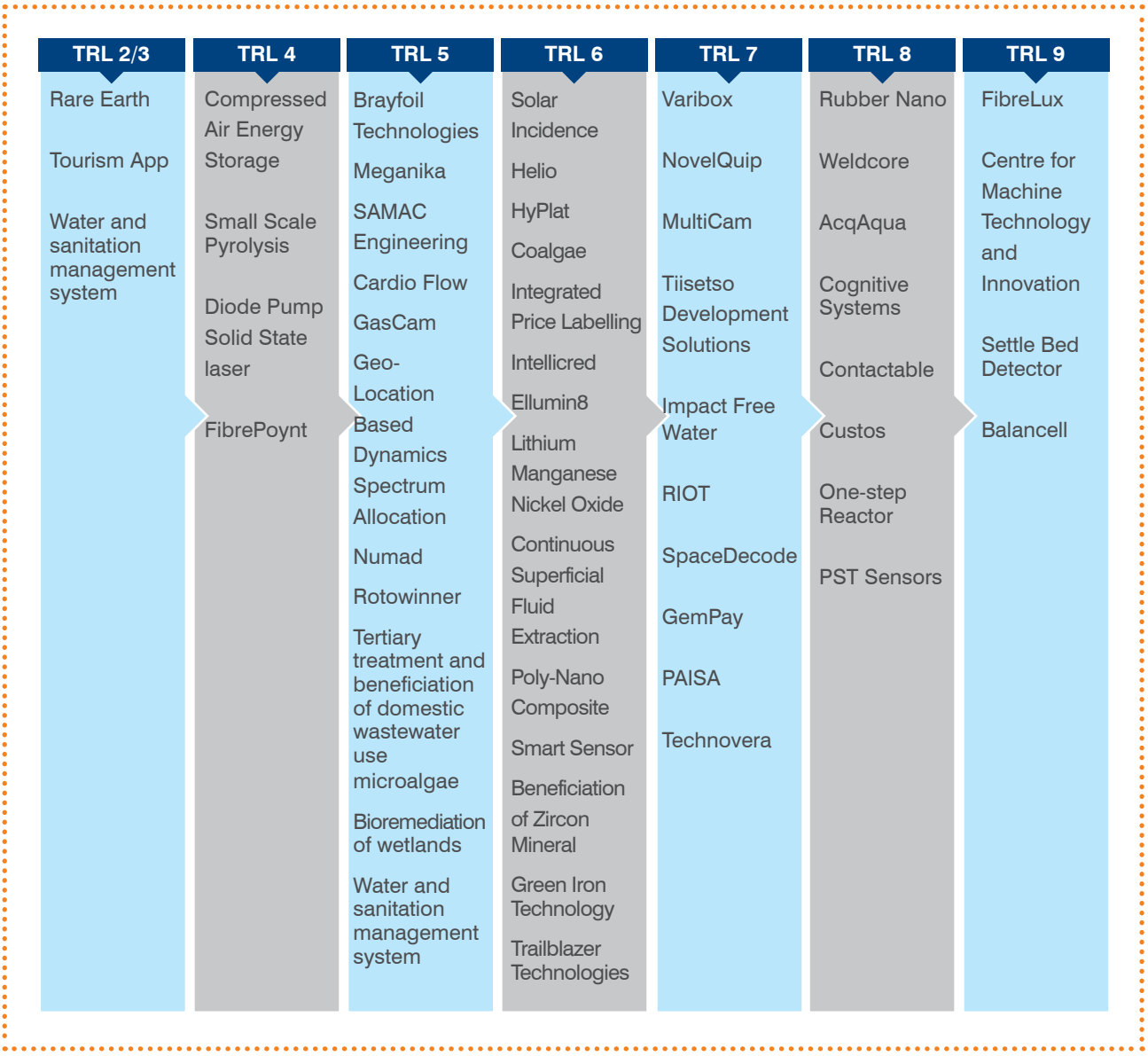


Figure 9. Technology readiness level status of active projects in the Sector Funding division

Scaling up the Seed Fund Programme

The Seed Fund Programme has demonstrated a good track record as an instrument for sourcing promising projects from the research community and small, medium and micro enterprises. As a result, many of TIA's projects that made it to market were largely from the Seed Fund Programme portfolio. This fund will be deployed with greater intensity and scaled up through effective funding partnerships. Critical to this will be to foster better alignment between the Seed Fund Programme and the other TIA funding instruments to ensure a streamlined funding process that maximises TIA's limited funding resources. These funds will be aligned with key strategic focus areas across all provinces within the various sectors identified, and as a result, the sourcing of projects from universities, science councils and small, medium and micro enterprises will be directly connected with the thematic areas identified in the strategic plan. Specifically, the fund will be directed to stimulate innovation initiatives in the underserved provinces in partnership with the economic development agencies and other relevant stakeholders. This will assist in promoting the geographical diversity of TIA's portfolio.

Consolidation of TIA funding instruments

Improving TIA's commercialisation efforts requires the agency to streamline its funding instruments to ensure a smooth transition from one fund to another. TIA provides risk funding through the Seed Fund Programme, Technology Development Fund and the Pre-Commercialisation Fund. The impact of these funds is negatively affected by the disparate manner in which they are organised resulting in multiple processes that underpin systems and frameworks. In many ways, this has undermined the smooth transition of projects from one fund to another. TIA will therefore consolidate all its funding instruments into one Innovation Fund that will be governed by a single process and framework. This will ensure quicker turnaround times for decision-making and the provision of coordinated support to projects to ensure that they progress rapidly to the market.

Technology Acquisition and Deployment Fund

TIA, in partnership with the DSI, is piloting the Technology Acquisition and Deployment Fund with the aim of facilitating the commercialisation of locally developed technologies and promoting their uptake by the public sector to improve their operations, enhance service delivery and address pressing socioeconomic challenges. Through this fund, South African entrepreneurs, start-ups and small, medium and micro enterprises will have the opportunity to access much-needed capital for market testing and the demonstration and validation of their innovations in real market and operational settings.

Ecosystem approach to innovation

Given TIA's funding constraints and the need to fully exploit South Africa's knowledge endowments and the capabilities of the National System of Innovation, the agency will increasingly adopt an ecosystem approach to the identification and funding of projects. This approach will promote increased collaboration with key stakeholders in the National System of Innovation who will bring to bear their expertise, co-funding, networks and knowledge of technology trends. The Technology Innovation Cluster Programme will form an important basis for the launch of various initiatives for the bio-economy and industry. This will be underpinned by the establishment and funding of themed sector networks that will bring together industry, the research community and other international experts to share ideas, exchange knowledge and initiate strategic innovation programmes to be funded by TIA.

Innovation led by industry demand

The White Paper on Science, Technology and Innovation identifies increased support for and collaboration with the business sector as a specific policy intent. The 2019 National Advisory Council on Innovation Science, Technology and Innovation Indicators report reveals a few insightful findings on the role of business in research, development and innovation. Key among these are that government spending on business has decreased, as a percentage of gross domestic product, from 0,6% in 2007 to 0,4% in 2017; and that researchers are moving from the business sector into the academic sector, making business more reliant on partnering with universities to source innovative solutions to their challenges. As a result, South Africa is spending less on innovation led by industry. Through the Thematic Network initiative and TIA's funding instruments and technology infrastructure, the agency will seek to deepen its linkages with the private sector to identify demand opportunities for science, engineering and technology interventions within key sectoral value chains that enhance industry's productivity and competitiveness. This is in line with the Sector Innovation Fund managed by the DSI, in which TIA will play a role.

International partnerships

Through its International Partnerships Programme, TIA will promote the development of joint innovation initiatives between South African researchers; small, medium and micro enterprises; and companies with carefully selected counterparts in countries in Europe, the Americas and Asia. This approach will enable South Africans to access much-needed knowledge and technology transfer, international expertise, intelligence on trends in global markets, and access to high-end research and development facilities. The co-funding model with international partners will promote a cost-sharing approach per project. Through this approach, TIA will leverage more resources within the context of its budgetary constraints while increasing opportunities for accelerating its investments towards commercialisation and faster access to global markets.

Enhancing the role of the bio-economy in economic development

The bio-economy has attracted significant interest as a means to address some of the major challenges characterising the 21st century. The cross-cutting nature of the bio-economy offers a unique opportunity to comprehensively address interconnected societal challenges, such as health care and the burden of disease, food security, the scarcity of natural resources, dependence on fossil fuels and climate change, while achieving sustainable economic growth.

Advancements in biotechnological research and resultant uptake of innovation will allow South Africa to improve the management of its renewable biological resources and open new and diversified markets in food and bio-based products. South Africa has a significant capacity for knowledge generation in the bio-economy domain, which has the potential to maintain and create economic growth, develop and grow capabilities in human resources, increase the number of jobs and businesses, and improve the economic and environmental sustainability of primary production and processing industries.

TIA will target the health, indigenous knowledge systems, agriculture and industrial biotechnology sectors. The capacity to generate knowledge in these sectors and promote collaboration between the public and private sectors is essential for the enhancement of existing value chains and the creation of new ones. The successful implementation of this strategy requires a high degree of alignment and engagement among multiple stakeholders and role players across the ecosystem. TIA's bio-economy agenda is aimed at strengthening the agency's ability to inform research and innovation in the relevant sectors, and facilitate a more coherent policy environment and a more engaged public dialogue.

By focusing on the following points, TIA expects the bio-economy to yield great benefit to South Africa by:

- ensuring food security;
- managing natural resources sustainably;
- reducing dependence on non-renewable resources;
- mitigating and adapting to climate change;
- creating jobs and improving competitiveness;
- creating a coherent policy environment;
- investing in knowledge, innovation and skills;
- ensuring participative governance and informed dialogue with society; and
- creating new infrastructure and instruments.

State of the bio-economy in South Africa

Research, development and innovation

Bio-economy-related research is thriving in universities, science councils, government research units, industry associations and private research facilities. This research is generally aligned with national priorities such as infectious diseases, food security, climate change and the environment. Despite some weaknesses such as low investment in research and development, a stagnant human resource base and declining business spend on research and development, there is a solid basis for TIA to continue with its translation of publicly funded intellectual property to advance the objectives of the Bio-economy Strategy.

Public and private funding of biotechnology

The early-stage development of biotechnology innovations is predominantly supported by government funding. This has served well to reduce the risk associated with early-stage investment opportunities, thus attracting other interested follow-on funding partners. The South African Venture Capital and Private Equity Association's 2019 Venture Capital Survey shows that the number of venture capital investments in biotechnology-related products has grown steadily over the past five years, particularly in health, medical devices, and food and beverages. Life sciences, biotechnology and agriculture account for a smaller proportion. The introduction of a private sector-funded Biotech Fund in 2019 bodes well for the growing venture capital market in South Africa, specifically the bio-economy sectors. TIA must continue to build appropriate strategic partnerships to boost this sector and diversify the sources of funding available to early-stage business enterprises.

Legislative and regulatory environment

The policy and regulatory environment for the stimulation of a knowledge-based bio-economy is a key enabler for the sector to thrive. South Africa has a sound regulatory environment for bio-based products in areas such health, agriculture and food, but one of key challenges remains the long turnaround times in the approval process. TIA, through the DSI and with other role players, must play an active thought leadership and advocacy role to improve the responsiveness of the regulatory system through the provision of evidence-based policy advice where appropriate.

Policy measures such as tax incentives for research and development exist to encourage technology-based innovation among business enterprises. In the public sector, innovation is incentivised through the 2008 Intellectual Property Rights from Publicly Financed Research and Development Act. The use of public procurement to stimulate innovation and create markets for South African products is not yet well developed. During the next five-year strategy period, the functioning of these schemes will be crucial to enable TIA and other role players to deliver on the objectives of the Bio-economy Strategy to improve innovation and commercialisation outcomes in agriculture, health, industry and the environment, and indigenous knowledge.

Agriculture

Agriculture remains a significant provider of employment, especially in rural areas, and is a major earner of foreign exchange. South Africa needs to ensure that the agricultural industry remains healthy so that it continues to contribute to the country's gross domestic product, food security, social welfare, job creation and ecotourism while adding value to raw materials. However, South Africa is affected by a number of global trends that influence food security, poverty, and the overall sustainability of food and agricultural systems. The main developments placing pressure on agriculture to meet the demands of the future are rapid population growth, a reduction in the amount of available arable land, the scarcity and/or depletion of natural resources, and climate change.

The agriculture sector must embrace efficient methodologies provided by advancements in sensors, robotics, and information and communication technologies to produce food in safe and environmentally friendly ways. Some of the influential trends over the next five years are expected to be:

- **Acceleration in technology:** The use of data will supplement what farmers know intuitively and, in some cases, challenge those assumptions. New products rely on aerial satellite imagery, greenness sensors, soil maps and millions of weather data points. Data ownership will be a subject of growing debate.
- **Resource scarcity:** More than 40% of the increase in food production since 1961 has been accomplished through irrigation, but groundwater supplies are finite. Farmland is fast diminishing as a result of urbanisation. Climate change also poses challenges. Scientists estimate that for each 2°C increase in temperature, key crop yields decrease by 10%.
- **Influence of environmental awareness:** From the use of fertilisers to pesticides, farmers must be mindful of a complex, growing web of regulations.
- **Flux in government policy:** Successive administrations in South Africa and other countries have established approaches to land use, biofuels, genetically modified organisms and monetary policy that seem likely to continue to affect the industry.

Health

The National Development Plan envisages a strong health system that works for everyone, produces positive health outcomes and is accessible to all for improved health and wellbeing. The plan targets the following health outcomes by 2030:

- Raise the life expectancy of South Africans to at least 70 years.
- Progressively improve tuberculosis prevention and cures.
- Reduce maternal, infant and child mortality.
- Significantly reduce the prevalence of non-communicable diseases.
- Reduce injury, accidents and violence by 50% from 2010 levels.

South Africa runs a two-tiered health care system comprising the public and the smaller, rapidly growing private sector. Access to affordable, high-quality medical care is a major challenge. The public health sector is under-resourced and caters for 84% of the population, whereas the highly resourced private health sector caters to only 16%. To eliminate this inequality and provide the population with essential universal health care coverage, government is in the process of implementing national health insurance.

The South African health sector has experienced significant challenges, in both communicable and non-communicable diseases, among a population facing a heavy burden of perinatal and maternal disorders, injury and violence. The country's burden of non-communicable diseases such as HIV and tuberculosis is considerable: South Africa is home to more people living with HIV than anywhere else in the world, and ranks the third among countries with the highest burden of tuberculosis, after India and China. However, as major non-communicable diseases (cardiovascular disease, cancer, diabetes and chronic respiratory disease) share common behavioural risk factors (tobacco, unhealthy diet, physical inactivity and the harmful use of alcohol), there are common pathways for prevention.

Figure 10 illustrates a "cocktail of four colliding epidemics" – maternal, newborn and child health; HIV/AIDS and tuberculosis; non-communicable diseases; and violence and injury.

Maternal, newborn and child health

- The increasing trend in the maternal mortality was reversed in 2010 and Maternal Mortality Rate reached **152 per 100 000** livebirths in 2015
- Under 5 Mortality Rate has declined from **80 per 1000 livebirths in 2003** to **34 per 1000** livebirths in 2016
- Neonatal conditions, HIV/AIDS, diarrhoeal disease and lower respiratory infections/ pneumonia need to be addressed to reduce child mortality further

HIV/AIDS and tuberculosis

- Marked changes in mortality have been experienced with declines corresponding with the roll-out of ART and the earlier PMTCT intervention - **153 000 people died** from HIV/AIDS in 2012 **compared to 300 000** in 2006
- **HIV/AIDS** remains the leading cause of death
  - efforts to provide access to treatment must be enhanced
  - prevention efforts must be strengthened, particularly among young women
- SA is estimated to have the biggest tuberculosis burden in the world - a sizable number of HIV/AIDS deaths are associated with tuberculosis

Non-communicable disease

- Non-communicable diseases, as a group, now account for the highest number of deaths in South Africa
- **Cardiovascular** conditions are the leading category of non-communicable disease deaths in South Africa accounting for **19% of deaths in 2012**
- Essential to address leading risk factors for non-communicable diseases i.e. smoking, alcohol, physical inactivity and diet, and provide primary healthcare to manage them

Violence and injury

- Interpersonal violence and road traffic injuries account for considerable premature loss of life - inter-sectoral actions are needed to change norms in society and build social cohesion
- **52% reduction** in death rate from interpersonal violence (homicide) between 1997-2012, accompanied political stabilisation in the country, and Fire Arms Control Act of 2000
- The **homicide** rate in South Africa remains much **higher than the global average**

Figure 10. South Africa's burden of disease (Source: South African Medical Research Council)

Indigenous knowledge-based innovation

As the world's third-most biologically diverse country, South Africa has a major comparative advantage. The country is home to almost 10% of the world's known plant species and 15% of all known coastal marine species. South Africa comprises nine unique vegetation types (biomes), of which three have been declared global biodiversity hotspots, and is also the only country to contain an entire floral kingdom – the Cape Floristic Region. South Africa's natural capital of biological diversity, combined with its wealth of indigenous knowledge, forms one of the country's greatest assets.

There is also a need to strengthen and coordinate the informal indigenous knowledge-based herbal medicines market to grow and formalise the African traditional medicines sector by seeking to add value through cutting-edge biodiversity-based bioprospecting and research in product development.

It is estimated that 80% of the South African population uses traditional medicine. The formalisation of the traditional medicines informal sector is expected to contribute to rural economic development, and has the potential to negate the trend to migrate to cities in search of employment. It will also enable the optimal management of indigenous biological resources and reduce the uncontrolled harvesting of certain wild plants, thus protecting them from extinction. This will contribute to environmental sustainability, economic development and improved household incomes in rural areas, and capitalise on the global demand for natural products.

Although progress in mainstreaming the development of and commercialisation in indigenous knowledge systems has been slow, there are promising signs that this is changing. The promulgation of the Protection, Promotion, Development and Management of Indigenous Knowledge Act (2019) is a significant milestone in the mainstreaming of the indigenous knowledge-based innovation. The Act aims to, among other things, protect and promote indigenous knowledge, and facilitate and coordinate indigenous knowledge-based innovation in South Africa. It provides TIA with a solid foundation to improve its portfolio of investment in indigenous knowledge systems and actively participate in national initiatives such as the multi-institutional BioProducts Advancement Network South Africa. TIA will work with its partners to develop support programmes that are inclusive in the sourcing of indigenous knowledge-based projects, provide technology development and early-stage commercialisation financing, and provide entrepreneurship support to establish sustainable enterprises.

In a survey of public perceptions on biotechnology, South Africans have commonly used biotechnology in the context of indigenous knowledge systems and practices[6]. Up to 47% of respondents reported using traditional medicines with varying frequencies, 44% reported using biological processes to prepare food, and 38% reported using traditional farming practices. The high levels of awareness and use of indigenous knowledge-based biotechnology in daily life provides a solid basis to promote innovation and local product development.

Industry and the environment

South Africa has historically grown its economy primarily through mining and the use of non-renewable resources. As these resources become increasingly limited, new technologies are being used to enable economic growth. The potential for industrial biotechnology to contribute to the bio-economy focuses on industry and sustainable environmental management. The focus on industry involves bio-based chemicals, biomaterials and bio-energy, whereas the focus on sustainable environmental management involves water and waste as means of providing environmental sustainability for the industrial bio-economy.

Furthermore, in line with global trends, there is a growing need to explore alternative and/or renewable raw materials for the production of commercially important products. Building a sustainable bio-economy requires a source of renewable materials. Plant biomass is widely considered a potentially useful substrate for use as raw material, but processes need to be optimised to make this a feasible option. Traditionally, South African agriculture does not process plant by-products, resulting in more than

[6] *Public perceptions of biotechnology in South Africa (2018).*

20 million tons of underutilised resources each year, with the uncontrolled growth of invasive plants contributing a further 17 million tons. There is therefore a need for enabling technologies that provide a feasible conversion of biomass at the industrial scale to a variety of value-added products that would also lead to job creation. Biorefineries are seen by many as key components of a strong, diversified bio-economy to enable the efficient conversion of a broad range of biomass feedstocks into commercially viable bioproducts.

Biorefineries provide the opportunity to introduce greener production processes to develop value-added products in an integrated economic and technically feasible manner. Biorefineries depend on specialised microbial strains that can efficiently produce fuels and chemicals from different feedstocks in high yields. Biorefinery products may either be integrated into existing value chains where they replace existing products, or bio-based products that are novel and cannot easily be integrated into existing value chains. However, the funding required to commercialise these products might be prohibitive.

Water scarcity is a South African and global challenge that highlights the need to seek new ways to conserve and recycle this important resource. The development of bioremediation solutions for wastewater treatment is an important intervention in the conservation of water and preventing the contamination of other natural resources. Wastewater treatment also offers the opportunity to extract useful materials using bio-based solutions.

The South African chemicals industry is highly diversified and plays a major role in the economy, contributing 25% to local manufacturing and 4% to the country's gross domestic product, mainly through commodity chemicals and mineral fuels. In recognising that it is critical to innovate to improve the competitiveness of the sector, the development of green chemical processes, preferably based on sustainable feedstocks to produce value-added products, must form part of the innovation agenda for the sector. Biocatalysis, using both enzymes and microbes, is an important capability to harness to realise such ambitions. Biocatalysis could help South Africa produce chemicals such as those found in pharmaceuticals in a cost-effective manner, as well as for products in food, beverages, medical supplies and various consumer goods.

Bio-economy initiatives

Figure 11 depicts each of the bio-economy subsectors with their respective areas of focus.

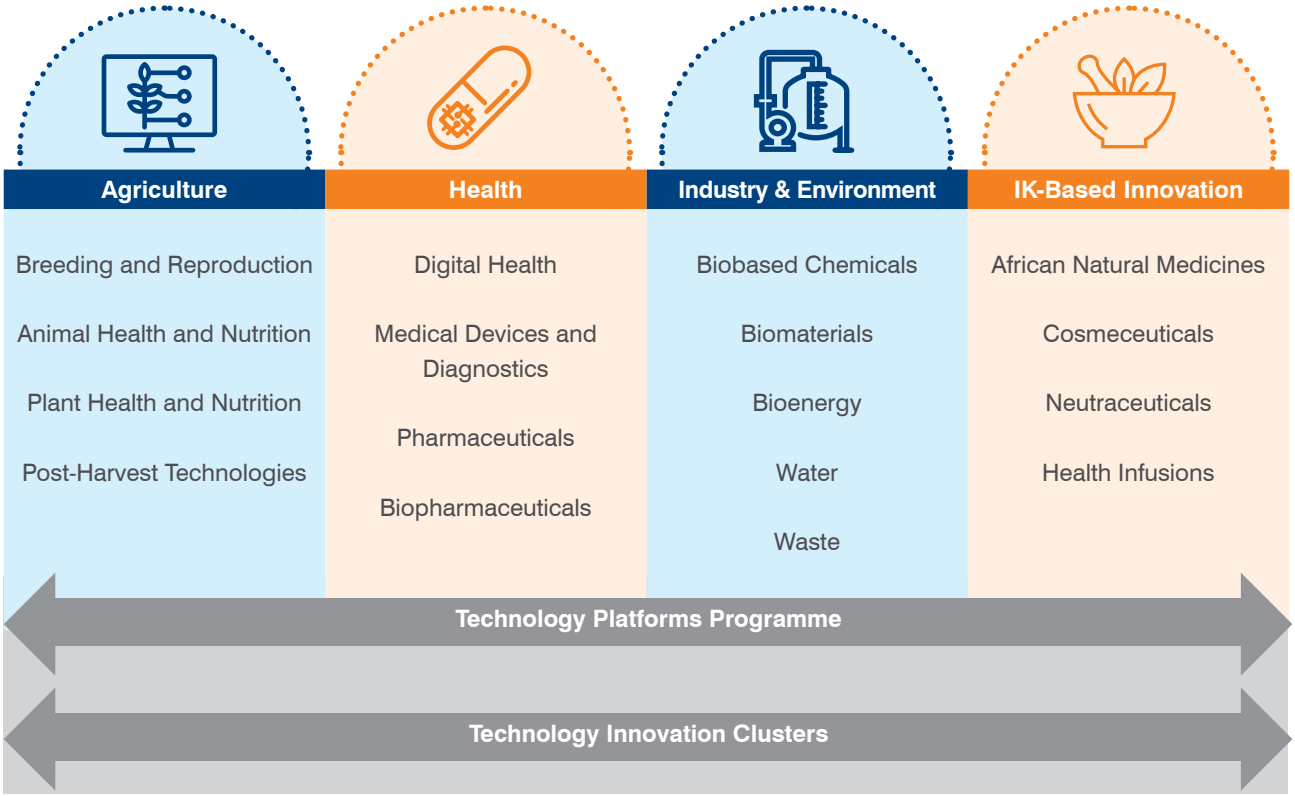


Figure 11: Bio-economy focus areas

Agriculture

The objectives of TIA's Agriculture subprogramme are to promote food security, rural and township development and economic transformation, and create more resilience to climate change across the agriculture value chain (Figure 12). In this regard, TIA will focus on developing and exploiting technologies in areas such as breeding and reproduction; animal health and nutrition; plant health and nutrition; and agro-processing and post-harvest technologies, including smart or information and communication technology-based agricultural technologies.

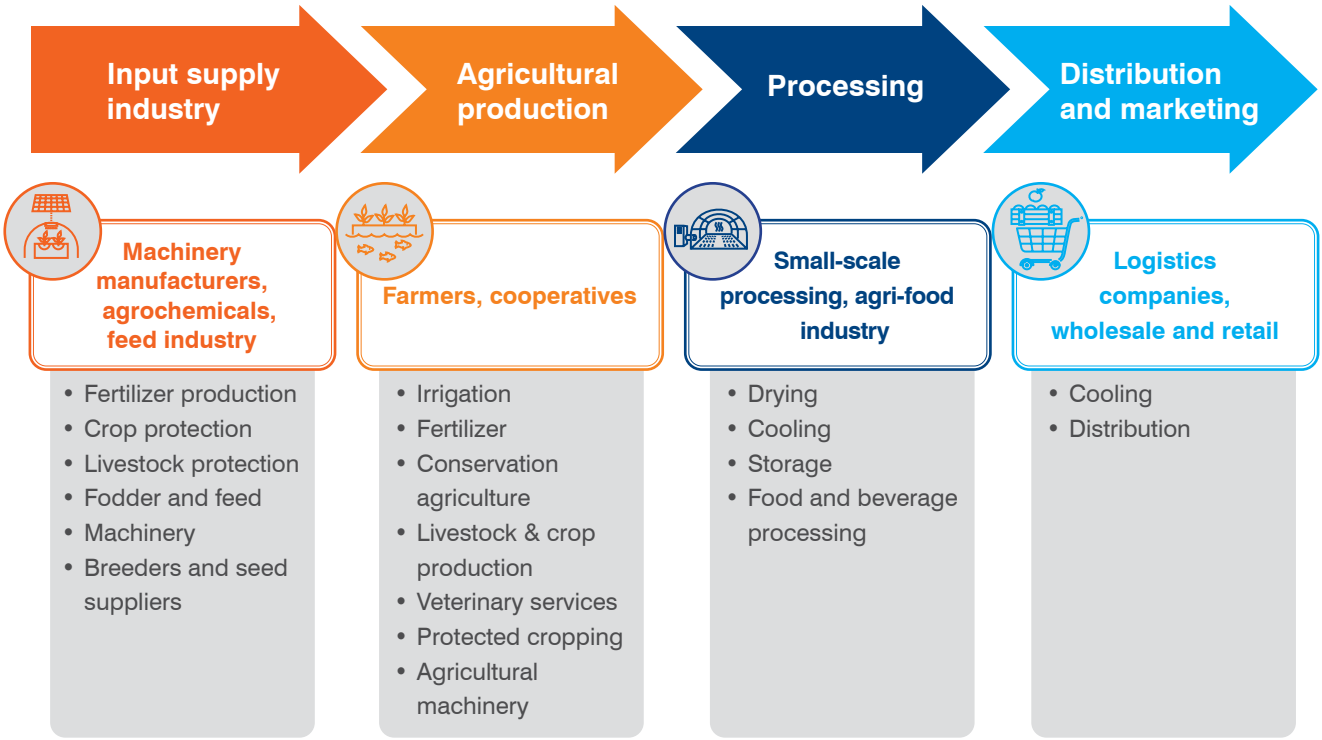


Figure 12. Agriculture value chain

- **Food safety, security and nutrition:** In line with the national 2017-2022 Food and Nutrition Security Plan and the Bio-economy Strategy, TIA will leverage technologies that are already developed to promote food security and nutrition. To this end, TIA will pursue opportunities in post-harvest technologies and storage or techniques to improve shelf life; agro-processing technologies and the detection of mycotoxins; and soil health and agronomic technologies.
- **Inclusive development and rural economic transformation:** TIA will partner with research institutions such as universities, the Agricultural Research Council and the Council for Scientific and Industrial Research to design broad-based deployment and diffusion of technology solutions. Through this approach, TIA will promote the transfer of technologies and knowledge benefits to poor people in rural communities and the informal economy.
- **Climate change resilience:** TIA will continue to support the development of technologies that enable agricultural production in adverse conditions that arise from erratic and changing climate patterns that cause severe drought and heavy rains. This will include pursuing opportunities in breeding and production technologies; drought- and disease-resistant technologies; early-warning technologies and diagnostics; and improved agronomic practices such as precision agriculture, no-till techniques and conservation agriculture.

Health

Through the Health subprogramme, TIA will work towards bridging the innovation chasm that exists between concept formulation and full-scale product manufacturing in the health value chain, as depicted in Figure 13.

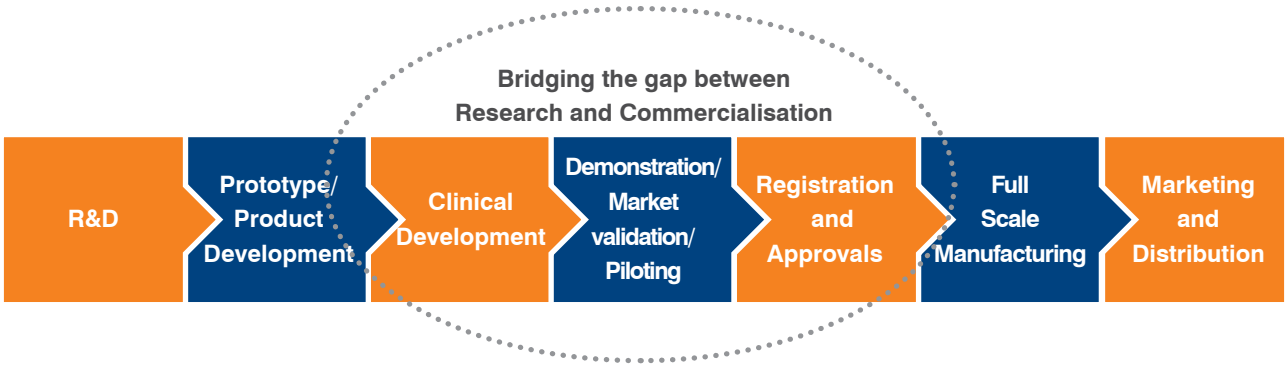


Figure 13. Health value chain

During the strategic period, TIA will support the advancement of health-related technologies through product development, validation and market testing. These efforts will be directed towards addressing the diagnosis and treatment of diseases relevant to South Africa and Africa more broadly. In so doing, TIA will seek to exploit the confluence of digital technologies and big data to improve the delivery of health care services, in line with priority 3 (education, skills and health) of government's 2019-2024 Medium-Term Strategic Framework. Future investments will mainly prioritise digital health, medical devices and diagnostics, including technologies that improve access to health care and address high-burden diseases.

- **Digital health:** This area promises to provide myriad solutions to address challenges in health care. The Department of Health's eHealth Strategy is aimed at developing an integrated, national patient-based information system that is able to interface with other systems used in the health sector. eHealth covers technologies in electronic health records, health management information, consumer health informatics, telemedicine, virtual health care, mobile health and health research.
- **Medical devices and diagnostics:** This is a key area of intervention to contribute to equitable and affordable access to health care for all. TIA will target technologies that address early screening or the timely and more accurate or efficient diagnosis of diseases, as well as the management of disease.
- **Pharmaceuticals:** TIA will target opportunities that are at a late stage (pre-clinical and later) in cases where co-funding or collaboration with other partners exists through arrangements such as public-private partnerships or product development partnerships. This will be done through ongoing investment in relevant Technology Platforms, programmes and clusters for drug development and industries that manufacture active pharmaceutical ingredients. Artificial intelligence will further support enabling interventions and programmes to address gaps and shortfalls in the industry.
- **Biopharmaceuticals:** There are opportunities to explore biosimilars or biobetters and other innovative production technologies, such as biopharming and biologics. Opportunities also exist to assist local industry development, potentially including bioprocessing, quality control laboratories, and protein engineering or production.

- **Precision or personalised medicine:** Through initiatives such as genomics platforms, TIA will continue to support existing sites that generate and analyse big data. This provides scope to implement genomic and precision medicine solutions, particularly for African populations, and further assess the landscape for other emerging technology areas.

Industry and environment

Bioprocessing technologies are used to convert various types of feedstock or biomass into useful products, ranging from bulk products to fine, high-value products. Water security is a global problem, and the recent droughts in South Africa have thrown this issue into sharp relief. The use of wastewater as feedstock in bioprocessing technologies can be deployed to remediate wastewater while producing valuable products. The integrated biorefinery approach provides the opportunity to use renewable biomass to generate high-value products such as proteins, fine chemicals, carbohydrates and oils, which in turn create potential economic opportunities. The use of bio-based solutions in industrial processes is depicted in Figure 14.

TIA will also support existing bioprocessing and biomanufacturing capabilities for product development and the creation of small, medium and micro enterprises. The establishment of biorefinery initiatives will be a priority over the next five years, particularly the development and deployment of technologies such as extraction and formulation processes within the natural products industry. The focus in this sector will be primarily on bio-based chemicals and, more broadly, on bioproducts, bioremediation and waste beneficiation.

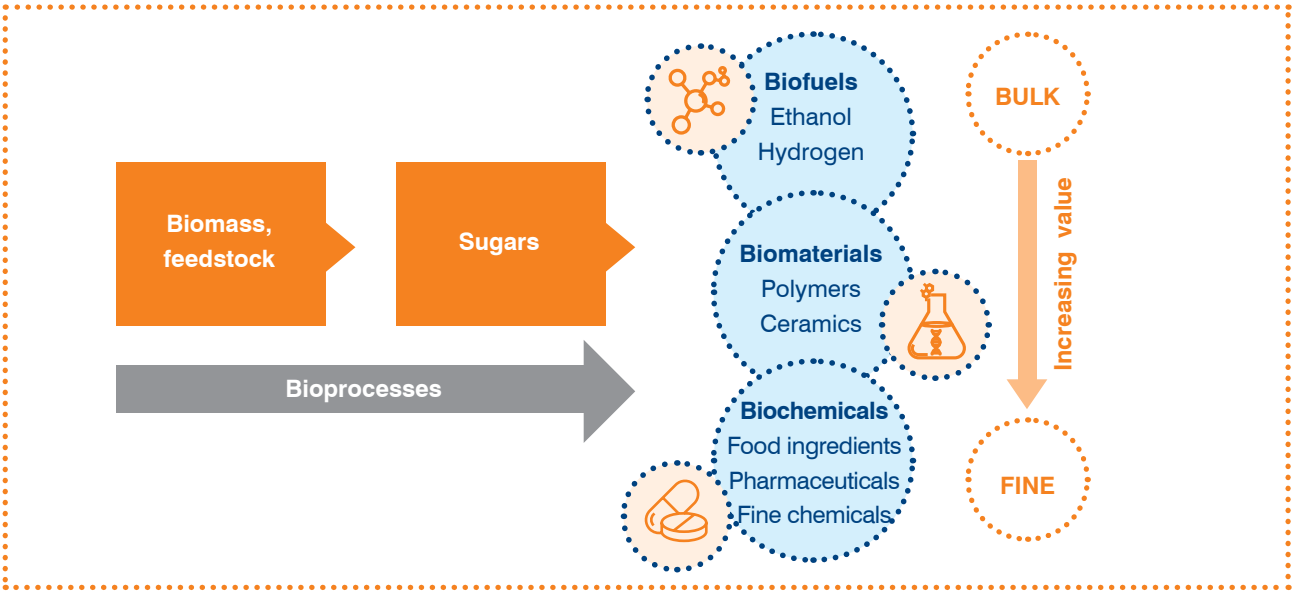


Figure 14. Industrial biotechnology value chain

- **Bio-manufacturing industry development:** In partnership with the Council for Scientific and Industrial Research and other role players, TIA will establish a dedicated programme for new and existing small enterprises in the biomanufacturing sector. The primary thrust of the programme will be to use a value chain approach to improve the local production of bulk and specialty biochemicals such as nutraceuticals, flavourants and cosmeceuticals, with a specific focus on building small enterprises. The secondary thrust will be to develop human capacity by encouraging small, medium and micro enterprises to participate in the programme to create critical mass within the biomanufacturing sector.

- **Biocatalysis:** TIA will support investments in projects, programmes and initiatives that deploy biocatalytic technologies to develop products in various industries including fine chemicals, polymers, textiles, cosmetics, flavours and fragrances, with a particular focus on technologies that reduce manufacturing costs and environmental impact, and use more benign process conditions. Biocatalysis uses enzymes or micro-organisms to replace conventional industrial chemical processes, and provides alternative manufacturing solutions.
- **Integrated biorefineries:** This approach will be adopted to invest in projects and programmes that use renewable biomass to produce a range of chemical outputs. Outputs include bio-energy, bio-based chemicals, biomaterials, food, and animal feed products. TIA will work with other partners to consolidate various activities and develop strategic capabilities to realise integrated biorefinery approaches. A key component of this strategy is to provide support to the forestry and sugar industries to improve the use of forestry and sugar cane biomass, and the exploitation of algal biotechnologies.
- **Wastewater bioremediation:** Domestic and industrial wastewater contributes to environmental pollution and degradation. TIA will support projects, programmes and initiatives that focus on the treatment of domestic and industrial wastewater and acid mine drainage to acceptable standards before discharge. This includes supporting projects and programmes to promote bioremediation and the rehabilitation of contaminated areas, including landfills.

Indigenous knowledge systems

TIA will use sectors such as indigenous knowledge to support economic transformation and promote inclusivity, particularly of historically marginalised segments of society. Indigenous knowledge systems hold great potential for the establishment of new industries, and, as such, the sector is poised to give South Africa a competitive edge internationally. The capacity to generate knowledge in this area and the promotion of public and private collaboration are important pillars for enhancing existing value chains and creating new ones. The successful implementation of this industry requires a high degree of alignment and multi-stakeholder engagement with role players across the ecosystem.

South Africa has a rich biodiversity and long-held knowledge systems on the use of various flora. This resource base provides opportunities for the development of commercially viable products in African traditional medicines, and cosmeceutical and nutraceutical industries, as depicted in the broad value chain in Figure 15.

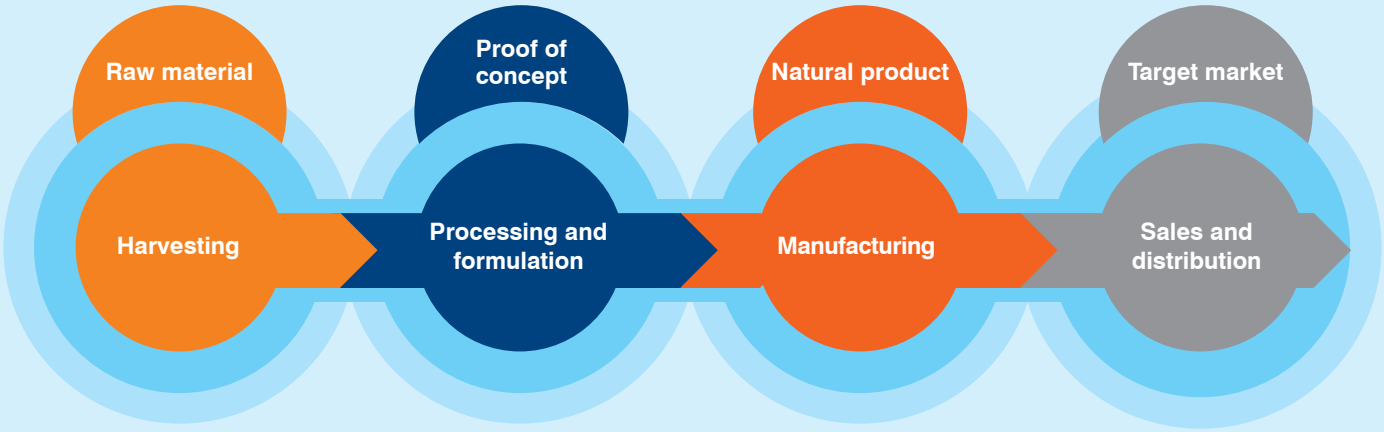


Figure 15. Natural products value chain

TIA will harness indigenous ideas by supporting the development of technologies to conduct process development, product formulation and, where necessary, the clinical validation of indigenous-based natural products. These products have the potential to benefit from increasing consumer demand for naturally produced medicines, foods, beverages and cosmetics. TIA aims to grow the proportion of funding dedicated to investments in indigenous knowledge-based projects and programmes in its portfolio. The agency will adopt inclusive innovation approaches that make knowledge holders and communities part of the development and commercialisation value chain, and thus contribute to the creation of community-based enterprises and jobs. To this end, TIA will pursue opportunities in:

- **African traditional medicines:** One of the key focus areas will be to build capabilities to support the validation of efficacy and the safety of African traditional medicines, and support their mainstream commercialisation. TIA will also provide financial and non-financial support that promotes inclusivity of indigenous knowledge holders in product development and commercialisation.
- **Cosmeceuticals, nutraceuticals and health infusions:** TIA will establish facilities to assist in product development and the pre-commercial manufacturing of nutraceuticals and cosmeceuticals. In addition, the agency will use the capabilities of its innovation infrastructure in Technology Platforms and Technology Stations to support these initiatives.

Collaboration with key stakeholders in the ecosystem will form an important component in the development value chain for indigenous knowledge-based products. In this role, TIA will provide funding for technology development, competencies and infrastructure capabilities to increase the creation of and support innovative start-ups and small, medium and micro enterprises. The agency will also leverage the capabilities of existing stakeholders such as the Small Enterprise Development Agency for the provision of entrepreneurial support.

Technology Platforms Programme

Technology Platforms seek to achieve efficiencies in key biotechnology innovation value chains through centralising the development and application – with the associated infrastructural costs – of certain technological capabilities so that they are accessible to and shared with others, rather than funding individual entities or projects to acquire such capacity independently. Technology Platforms will continue to be selected based on their potential to support technology development in various sectors of the economy. One of the key considerations that will inform the choice to invest in certain technological capabilities will be the extent to which these technologies can contribute to the achievement of national priorities and deliver value in line with the Bio-economy Strategy.

Investments in technological infrastructure over the next five years will be guided by optimising the use of existing capabilities to support biomanufacturing endeavours for small enterprises; strengthening support for indigenous knowledge-based innovators in various value chains in product development, market testing and validation; enhancing access to large-scale infrastructure requirements to successfully realise integrated biorefineries; developing capabilities for technology and product development in veterinary and human health applications; and developing capabilities to exploit conversion technologies, such as big data generation and analysis to exploit local opportunities, amongst other measures.

Technology Innovation Clusters Programme

TIA stimulates the development of value chain activities or mechanisms to facilitate sector- or industry-level engagement through the crosscutting approach adopted in the Technology Innovation Clusters programme. This is intended to address systemic weaknesses that hamper innovation and commercialisation beyond just the provision of funding to individual projects.

Through this programme, TIA manages a number of initiatives that are strategically aligned with national priorities. These include agricultural programmes in areas such as beef and dairy genomics, animal health and forestry molecular genetics. Clusters relevant to the health sector include active pharmaceuticals, nuclear medicines, and medical devices and diagnostics.

Positioning Technology Stations for enhanced small, medium and micro enterprise support

TIA provides a wide range of science, engineering and technology support through its network of 18 Technology Stations throughout the country. These largely serve as technology transfer centres that offer support to small, medium and micro enterprises and access to high-end equipment, and are resourced with experts in specialised fields to develop new products and processes. They effectively serve as technology nurseries that play an important role in lowering barriers to entry for innovators, and have been successfully deployed to provide small, medium and micro enterprises and industry with various technology packages. During the previous strategic period, TIA provided support to more than 10 000 small, medium and micro enterprises and individual entrepreneurs.

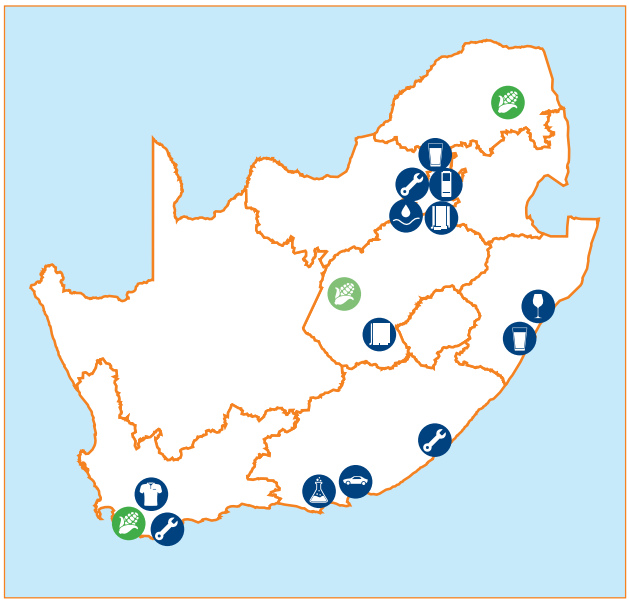


Figure 16. Network of Technology Stations

However, the Technology Stations model is no longer adequate to service the needs of an evolving innovation landscape. The increasing diversity of sources of innovative ideas has widened to include entrepreneurs outside formal systems of innovation, such as grassroots innovators, non-governmental organisations and other community-based organisations, as opposed to only the scientific community.

Government has placed emphasis on small, medium and micro enterprise development as important policy priority to promote the establishment of viable enterprises to spur new businesses, and thereby stimulate job creation and reduce unemployment and poverty.

The imperatives of transformation require an increase in the spatial footprint of innovation in South Africa that will contribute to the improvement of local economies through the creation of a stronger role for innovation in rural development and support for regional and local systems of innovation.

The White Paper on Science, Technology and Innovation envisages a number of important shifts regarding the positioning of Technology Stations. Firstly, as these provide innovative science, engineering and technology solutions for complex engineering challenges within various industrial sectors to support government's socioeconomic priorities, TIA will position the stations to support the effective implementation of various sectoral master plans. Secondly, efforts will be intensified to support the localisation and diffusion of technologies through existing and new technology-based support interventions. Thirdly, the White Paper on Science, Technology and Innovation acknowledges that small, medium and micro enterprises often struggle to innovate, perform research and development, access knowledge and absorb new technology. As a result, through interventions such as walk-in support at Technology Stations, the delivery model will be scaled up to provide broad-based support to these enterprises to ensure that more of them are able to access services, equipment and support in product and technology commercialisation.

Technology Stations will be scaled up and repositioned as a package of offerings in the National System of Innovation, leveraging complementary features with other government and industry support instruments. However, TIA is aware that the concentration of these facilities in cities and metros implies that budding entrepreneurs in rural areas and townships face the risk of further marginalisation. As a result, in the strategic period, TIA will work to build on this solid foundation to ensure that the science, engineering and technology support provided to small, medium and micro enterprises and entrepreneurs is strategically informed and regionally distributed through a number of initiatives.

In doing this, the agency will seek to:

- increase the performance and relevance of Technology Stations, enabling them to serve a larger number of small, medium and micro enterprises and entrepreneurs. This will involve the drive to modernise facilities, ensuring that they are accredited and adequately geared to respond to the challenges and opportunities arising from the fourth industrial revolution and sectoral master plans.
- expand and diversify the suite of science, engineering and technology support to enhance reach to marginalised communities through models such as Living Labs, technology incubators and walk-in centres, thereby improving spatial inclusivity. This is particularly important in light of the changing nature of sources of innovation to include grassroots innovators and cooperatives. In expanding science, engineering and technology support models, TIA will work with other partners such as industry, township hubs, accelerators and incubators to explore opportunities for co-location and shared services.
- provide technical and vocational skills that are sectoral specific in partnership with training authorities. In this regard, Technology Stations will partner with the Quality Council for Trades and Occupations, sectoral education and training authorities, and technical and vocational education and training institutions to ensure that educators are equipped to teach learners the necessary skills required by industry.

All these efforts are important in light of the imperatives arising from the National Spatial Development Framework and the District Development Model, both of which seek to promote the coordination of effort across government at local and district level. Through this, TIA aims to increase its spatial footprint and double the number of innovators who have access to key innovation infrastructure facilities and the requisite support. More importantly, Technology Stations will be positioned to support the objectives of the various sectors identified by the Department of Trade, Industry and Competition's Reimagining South Africa's Industrialisation initiative.

7. Strategic enablers for enhanced performance

To deliver on its strategy, TIA will leverage and activate a number of key levers that will serve to enhance its ability to achieve its set objectives effectively. These include building and leveraging strategic partnerships for increased funding in the National System of Innovation to bolster TIA's funding base and resources; creating partnerships to develop innovation skills and a national culture of innovation; enabling thought leadership for system-wide impact; and implementing measures to increase operational efficiency and effectiveness.

Consequentially, TIA will consolidate a number of its innovation-enabling programmes to enhance their potential for maximum impact. In the strategic period, various programmes will be streamlined to strengthen the agency's impact on the creation and provision of support to start-ups and small, medium and micro enterprises. Effort will be directed towards strengthening transformation, economic inclusivity, and the development of viable enterprises in rural and township economies. Emphasis will be placed on supporting women, youth and people with disabilities.

Partnerships for funding and commercialisation

Over the past five years, TIA established a wide range of partnerships with various stakeholders in the National System of Innovation. These include science councils, higher education institutions, development finance institutions, the private sector, national and provincial government, and African and other international partners. Through these, TIA has sought to promote collaboration and coordination among various constituents of the National System of Innovation to bolster the execution of its mandate and develop sound strategic capital for its main clients – innovators. During this period, TIA successfully piloted various partnership models, which will be scaled up for maximum impact.

Partnerships for enhanced system co-ordination

Through the Glass Pipeline model, TIA promotes interconnectedness within the National System of Innovation. The model is intended to increase visibility of innovation activity throughout the innovation value chain and promote the seamless progression of innovative projects from lab to market. This is articulated as the backward and forward integration approach that systematically links TIA with the upstream knowledge-generation community that feeds into the investment pipeline, as well as a wide range of downstream ecosystem players that serve to enable the successful

commercialisation of technologies though follow-on funding and support once they have been through the TIA funding cycle.

In the strategic period, TIA will implement this partnership model with greater intensity through three workstreams:

- **Intensified engagements with science councils and higher education institutions** to leverage existing relations to enhance the commercialisation of publicly funded intellectual property. Throughout this process, due consideration will be given to the imperatives of transformation and inclusivity in support of transforming the demographic ownership profile of technology-based firms, and enabling the commercialisation of intellectual property for the benefit of black entrepreneurs, women, youth and people with disabilities. TIA will work closely with the National Intellectual Property Management Office, the Southern African Research & Innovation Management Association, and the South African Technology Network to strengthen the capacity of Offices of Technology Transfer as key agents for identifying promising research output in universities and engaging in commercialisation efforts.
- **Enhanced efforts to strengthen partnerships with industry**, made up of large private sector organisations, state-owned enterprises and locally based multinational corporations. This will require closer collaboration with the Department of Trade, Industry and Competition to identify sectors in which there is a strong need for technology innovation to promote the revitalisation of ailing industries and competitiveness. Collaboration with the private sector, industry bodies and associations is expected to lead to partnerships around joint calls for proposals, innovation competitions and joint funding. Through this, TIA will support the DSI's efforts in implementing the Sector Innovation Fund.
- **Development finance institutions and instruments** constitute important partners for joint funding, follow-on funding and business development support for projects in which TIA invests. Partnerships with government innovation-funding instruments will be enhanced, in particular with and through the Support Programme for Industrial Innovation, the Technology and Human Resources for Industry Programme, the Small Enterprise Development Agency, the National Empowerment Fund, the Small Enterprise Finance Agency, the National Youth Development Agency and a range of regional agencies and other support intermediaries for small, medium and micro enterprises to create formal referral mechanisms for innovators.

Hub-and-Spoke partnership model

TIA's Hub-and-Spoke partnership programme positions the agency as a national innovation management and funding instrument. The funding model aims to promote the allocation of funds by various government departments and their entities, at the national, provincial and local levels, dedicated specifically to the development and execution of strategic innovation programmes to support service delivery mandates. Through this, TIA will deploy its institutional capabilities such as fund management, project management, technical competencies and technology infrastructure to underpin systems and processes across government.

The DSI's 2017 Survey on Government Funding for Scientific and Technological Activities reveals that an estimated R23,4 billion was spent on scientific and technological activities in 2016/17. Many government departments have identified innovation as an important enabler for addressing pressing strategic national challenges in various sectors such as energy, agriculture, security and human settlements, with some departments even having established innovation programmes. TIA has worked with departments such as Tourism, Communications and Digital Technology, and Agriculture, Land Reform and Rural Development to design and initiate focused programmes that aim to support the execution of their mandates through innovation.

In 2018, the DSI concluded and approved the Framework for Science and Technology Cooperation with government departments. The White Paper on Science, Technology and Innovation has subsequently included a specific policy intent to promote the use of government procurement as a lever to increase innovation. The DSI has also established the Innovation for Service Delivery programme. These key initiatives represent important opportunities for close collaboration to pursue innovation with greater intensity in the future.

International Partnerships

TIA's International Partnerships programme, in collaboration with the DSI, is an important enabler for scaling up South Africa's innovation capability and promoting greater connectedness with global innovation ecosystems. Through this programme, TIA pursues partnerships at bilateral and multilateral levels to promote:

- collaborative research, development and innovation initiatives that will enable South African enterprises to leverage international expertise and provide access to high-end facilities around the world.
- market access and international networking for TIA investees and other deserving, outward-looking, technology-based small, medium and micro enterprises.
- capacity-building partnerships for the National System of Innovation, consisting of skills transfer on innovation management and commercialisation.

In line with the intents of the White Paper on Science, Technology and Innovation and government's 2019-2024 Medium-Term Strategic Framework, TIA's international partnerships strategy is expected to strengthen collaboration with countries in Africa. TIA has established strategic partnerships with like-minded institutions in various countries on the continent, such as Tanzania, Zambia and Egypt, where TIA has secured co-investment partnerships; and with Ghana and Botswana, with a specific focus on capacity-building initiatives for the National System of Innovation. Further efforts are under way to finalise new partnership with countries such as Tunisia, Angola, Kenya and Rwanda. The primary aim of these engagements is to promote the translation of research outputs from historical bilateral partnerships in which the DSI has traditionally invested through the National Research Foundation.

Recently, two significant developments in Africa for TIA are the establishment of the Africa Continental Free Trade Agreement and the adoption of the Southern African Development Community Innovation Programme by the region's Ministers of Higher Education, Science and Technology. These initiatives will see TIA playing an important role, working closely with the DSI and the Department of Trade, Industry and Competition, to leverage opportunities created by these platforms.

Further afield, TIA's international partnerships are expected to leverage resources through co-investment in joint technology and innovation development projects; promote market access and the internalisation of promising South African technologies and small, medium and micro enterprises; and attract interventions to develop skills for the benefit of the South African National System of Innovation. TIA has been working with several international partners in Europe, the Americas and Asia to drive initiatives connected to these objectives. These include, among others, implementing the Soft Landing programme with France and the United Kingdom, through which more than 40 TIA investees have participated in market access and partnership programmes that aim to support commercialisation.

An important policy intent of the White Paper on Science, Technology and Innovation is to increase funding to the National System of Innovation with a focus on increasing foreign investment. Development cooperation programmes of many bilateral partners in the Global North are aimed at supporting the attainment of the United Nations sustainable development goals. Therefore, development cooperation funds are expected to form an important source of funding innovations in South Africa that are geared towards solving pressing socioeconomic and challenge-driven innovation initiatives. In this regard, TIA implements the Southern Africa Innovation Support Programme, an initiative to support the development of functional and effective innovation ecosystems in selected countries within the Southern African Development Community region, including South Africa.

Partnerships for human capacity and a national culture of innovation

TIA's Business Case identifies two key enablers for the agency to succeed in delivering on its mandate, and promoting innovation skills and a culture of innovation. In the past few years, TIA has successfully implemented a range of initiatives through its Youth Technology Innovation Programme and Skills Development Programme to mobilise innovators, and young people in schools and communities to understand the concept of innovation and appreciate its value as it affects their daily lives. The White Paper on Science, Technology and Innovation highlights

the need to adopt a broader concept of innovation and its sources to include other models of innovation beyond research and development. TIA will build on its critical-thinking skills programmes, the FUTR500, to direct efforts towards supporting grassroots, youth-led and women-led innovation initiatives, particularly in marginalised township and rural communities, as this is where it is likely to make the greatest and most measurable impact in building a culture of innovation and promoting a culture of entrepreneurship.

In so doing, TIA will work closely with technical and vocational education and training colleges and community colleges, which will serve as key platforms for rolling out specific interventions aimed at empowering communities in marginalised environments. TIA will work with other key partners such as the South African Technology Network, which comprises seven universities of technology predominantly located in townships and marginalised communities. Key interventions for promoting a culture of innovation will include:

- awareness campaigns undertaken throughout the country, mainly under the auspices of the Science Engagement programme managed by South African Agency for Science and Technology Advancement.
- institutional capacity-building initiatives aimed at empowering local and district-level institutions such as technical and vocational education and training colleges and community colleges to support innovators.
- the hosting of and partnering with strategically selected events to showcase successful innovations and role models.

In addition to promoting a culture of innovation, TIA also launched and successfully implemented several initiatives to develop entrepreneurial skills. These have been targeted mainly at its investees so as to enable them to establish viable technology-based enterprises and take their technologies to market. Key among these are the Global Cleantech and the NextGen 100 programmes, which aim to select and accelerate the progression of the most promising innovators to market through a range of commercialisation skills. The technology enterprise component in TIA's Enterprise Development Framework (Figure 17) is largely geared towards beneficiaries that have developed technologies, are seeking market validation, are establishing start-ups and require support with business development activities to intensify their commercialisation efforts.

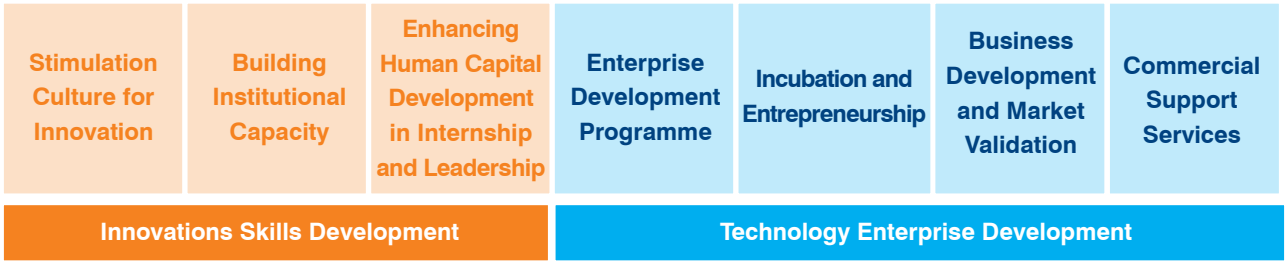


Figure 17. TIA's Enterprise Development Framework

Thought leadership for system-wide impact

South Africa has extensive expertise and knowledge in various technical fields across all sectors of the economy. Extensive research is being conducted in public research institutions, industry, government institutions and various sectors of society in the fields of biotechnology and other industrial sectors such as mining, energy, information and communication technology, and advanced manufacturing. The constrained fiscal environment and the government's pressures to devote resources to those areas that are likely to have greater impact on South Africa's socioeconomic challenges require careful investment decisions.

To harness this capacity and encourage research institutions and industry to share ideas, promote the transfer of knowledge and technologies, and act as innovation drivers in their specialist fields, TIA will establish Sector Thematic Networks. Each network will specialise in a specific area of innovation, and will serve to:

- promote knowledge exchange, dialogue and information sharing.
- identify common challenges and solutions, including relevant technology trends.
- play an important role in informing TIA's investment decisions and the design of appropriate funding instruments.
- initiate focused innovation initiatives and projects with visible impact on South Africa's socioeconomic challenges.

TIA has accumulated extensive experience through its past investment activities. This enables the agency to assist in informing policy and supporting the DSI in the development of decision support tools. TIA will continue to invest in this capability through the development of an effective knowledge management system and intelligence sources, and through its complement of competent staff with expertise in various disciplines. TIA will use this depth of knowledge to influence discussions and host dialogues on key issues that are pertinent to the discourse around innovation.

Operational enablers for efficiency and effectiveness

Systems

TIA's Information Technology Strategy focuses on business enablement and support through the implementation of functional systems for streamlined automation and business efficiency. As TIA's business evolves to align with evolving stakeholder demands and the external landscape, information technology will increasingly underpin every aspect of the agency's new business model for enhanced efficiency. This requires an information technology strategy to drive the creation of business value and outcomes that are impactful by enabling the automation of business processes and the delivery of services to internal and external stakeholders. It is essential that TIA's business model adapts to keep up with the pace of innovation by ensuring that stakeholder expectations are met. Speed, quality, agility and adaptability are the key attributes expected of such responsive information technology.

As a result, to enhance business performance and outcomes throughout the agency, TIA's 2020-2025 Information Technology Strategy will focus on integrated, end-to-end business solutions aligned with TIA's overall strategy and business processes across the value chain. The performance measure will be based on the enablement and improvement of business outcomes aligned with business target for value delivery. Strategic objectives will focus on:

- **Information technology as an enabler:** Information technology systems and business intelligence will be used to improve efficiency and ensure accurate information for decision-making and reporting. The consolidation of and collaboration between functional technologies and services to improve speed, agility and flexibility will enable the delivery of TIA's mandate within shorter turnaround times.
- **Information technology as a facilitator:** Information technology systems will be used to reach and support stakeholders in different geographical areas.

- **Information technology to enable agility:** Information technology must enable quick decision-making and processing to enhance stakeholder satisfaction. This will entail the reinforcement and optimisation of business intelligence and data analytics for performance measurement, and to provide insights into thematic areas.
- **Risk mitigation:** Secure and effective access to a growing inventory of information will be provided while ensuring confidentiality and integrity.

People

Difficult economic conditions, budget constraints and fierce competition to attract top talent are some of the challenges TIA faces. As the philosophy of remunerating employees at the 25th percentile of the national benchmark will not be sustainable over the strategic period, TIA will focus on the development and benchmarking of an employee value proposition to find solutions other than monetary compensation to recognise and reward top talent.

TIA will equip its human resources to be agile and responsive. They will be empowered with the skills, tools, systems and support needed to operate more effectively and be more adaptable. Through its talent management strategy and governance environment, TIA will create a high-performance culture with motivated and results-driven employees. Strategic objectives will focus on:

- **Employee value proposition:** Enhance the employee value proposition to attract and retain high-calibre, motivated employees.
- **Employees and technology:** Equip employees to operate from anywhere at any time, and be agile and effective. They need to be incentivised for knowledge sharing, innovation and engagement.
- **Talent management:** Ensure the right talent is in the right place at the right time. Equip human resources with the required skills and tools to enhance operational performance in a fast-changing environment.
- **High-performance culture:** Create a high-performance culture through incentives, policies and other human resources tools to help TIA achieve consistently high levels of performance to ensure the effective delivery of the agency's mandate and have a real impact on society.

Processes

Long turnaround times and decision-making processes combined with a lack of proactive communication lead to major frustrations for TIA's stakeholders. Improving operational efficiencies and reducing turnaround times will be an important priority as the new strategic period commences. This will enable TIA to maximise value from its expenditure on innovation and reduce administrative expenses.

TIA embraced business analysis and knowledge management as a key discipline to provide a platform to achieve operational excellence. Business analysis as a discipline creates a platform for developing and holistically managing the agency's process architecture – a hierarchy of end-to-end processes designed to create value for the customer – rather than a piecemeal improvement of specific processes and/or technology solutions. It further enables linkage between the core elements of people, processes, technology and information to drive organisational transformation and collaboration.

To improve the stakeholder experience and embed a culture of customer centricity, TIA will implement a number of initiatives to address these challenges:

- Re-engineer and develop coordinated and streamlined end-to-end business processes, including performance measures to monitor process effectiveness and efficiency.
- Introduce multidisciplinary assessment teams to shorten project assessment timelines by leveraging a wide variety of expertise in various disciplines.
- Implement the predictive call system, piloted by TIA in the previous financial year, to enable improved planning and allocation of resources, and greater efficiencies in assessment and approval processes.
- Establish a call centre to ensure that customers are attended to, and that customer complaints are measured, monitored and improved upon.

Facilities management

TIA will continue to provide its employees with a safe working environment to stimulate innovation and creative thinking through the acquisition and management of facilities, security services and office support services. Facilities management will ensure that the work environment is maintained in a cost-effective manner that enhances stakeholder satisfaction. It should be flexible to enable changes in the use of space when required.

8. Budget allocation for the 2020-2025 strategic period

In the 2019 State of the Nation Address, the President stated that unless we take extraordinary measures, we will not realise our vision of socioeconomic transformation by 2030. As TIA's budget over the five-year period is in line with this statement, the agency will prioritise effective cost management solutions and ensure that funds are appropriated to areas where they are needed the most.

The five-year strategic period begins with numerous structural challenges in the broader economy. This has already led to reductions on TIA's budget over the Medium-Term Expenditure Framework period, as approved by the DSI. Accordingly, the Board has directed the agency to focus on its mandate and core activities, and reduce its salary and administrative budget by R50 million in 2020/21. Funding for the technology development pipeline, a crucial area of the agency's funding activities, has been constrained by the availability of funds. This makes it necessary for the agency to adjust its budget by reducing staff and administrative costs to release funding for project and programme expenditure. Over the period ahead, funds resulting from these reductions will be reprioritised towards investments, as per Table 3.

Table 3. Budget for the 2020-2025 strategic period

	Budget 2020/21 R' 000	Budget 2021/22 R' 000	Budget 2022/23 R' 000	Budget 2023/24 R' 000	Budget 2024/25 R' 000	Total over 5 years R' 000
Administration	**173 094**	**171 106**	**179 661**	**188 644**	**197 726**	**910 231**
Support and infrastructure cost	60 244	58 256	61 169	64 228	67 439	311 336
Human resources	112 849	112 849	118 492	124 416	130 287	598 895
Investments	**447 764**	**464 793**	**473 713**	**489 423**	**506 257**	**2 381 950**
Bio-economy	206 476	215 474	220 754	229 029	238 768	1 110 500
Technology stations	96 713	99 019	100 685	103 019	105 470	504 906
Commercialisation	85 075	88 690	90 584	95 600	100 155	460 104
Innovation Enabling	59 500	61 610	61 691	61 775	61 864	306 439
Total Expenditure	**620 858**	**635 898**	**653 374**	**678 067**	**703 983**	**3 292 181**
Total funding received	620 858	635 898	653 374	678 068	703 984	3 292 181
Allocation from DSI	455 858	471 398	488 874	513 318	538 984	2 468 431
Baseline (other than Bio-economy and Technology stations)	217 426	220 091	228 268	239 681	251 665	1 157 132
Bio-economy	195 719	206 288	213 921	224 617	235 848	1 076 393
Technology Stations	42 713	45 019	46 685	49 019	51 470	234 906
Additional income target	154 000	154 000	154 000	154 000	154 000	770 000
Interest	11 000	10 500	10 500	10 750	11 000	53 750
Surplus/deficit	-	-	-	-	-	-

Staff and administrative costs

In ensuring that funds are made available for the agency to fulfil its mandate, significant reductions have been effected on staff and administrative costs. Staff costs amount to R598 million over the five-year period. Significant reductions are reflected in this amount, particularly in the first two years of the strategic cycle, as staff costs will be maintained by freezing vacant positions, cutting annual bonuses and filling only critical positions. For the three outer years of the strategic cycle, salaries will only increase in line with inflation. Costs related to support and infrastructure, which amount to R311 million over the period, will also be reduced through focused initiatives such as reducing costs associated with travel, rental and events. Funds realised from reductions in staff and support and infrastructure costs will be used to fund prioritised investments. Estimated savings over the five-year period amount to R361 million.

Investment funding

Investment in the following programmes will be prioritised over the period ahead: Bio-economy, Technology Stations, Sector Funding (commercialisation) and Innovation Enabling.

Bio-economy: As this is a key programme, all funds received from the DSI will be allocated to it. Total allocations from the department over the period amount to R1,1 billion, accounting for 46% of the investment budget. Of the total, a significant portion is for technology development, where focus will be placed on indigenous knowledge systems, industrial biotech, and partnering with other funders in the National System of Innovation with the aim of supporting the development of commercially viable products. Over the period ahead, TIA will continue to be a knowledge leader in the bio-economy space and partner with higher education institutions, science councils, and small, medium and micro enterprises to fund early-stage innovation.

Technology Stations: With a total allocation of R505 million over the five-year period, TIA will continue to support innovation through its Technology Stations Programme, which aims to translate ideas into prototypes and marketable products. Funding for the programme is received through the ring-fenced grant allocation and specific contracts from the DSI.

Sector Funding (commercialisation): The commercialisation unit focuses on development and commercialisation for product-funded projects. Deals that are currently in the funding pipeline are valued at R550 million, exceeding the amount for funding available. As such, most of the funds freed up through reductions in staff and administrative costs have been allocated to the Sector Funding programme. Total allocations over the five-year period amount to R460 million, which will be spread across various focus areas to fund technological development, commercialisation and early-stage seed funding. To streamline the funding process, the Seed Fund will be administered within the programme and will be deliberately aligned with key strategic focus areas in the various sectors. Greater emphasis will be placed on leverage funding and partnerships to manage the funding demand.

Innovation Enabling: The programme will focus on rural development, partnerships and enterprise development. It is mostly funded through partnerships and specifically contracted funds received from the DSI and other partners. Disbursements through the programme are expected to amount to R306 million over the five-year period. As the initiative is crosscutting, further funding will be made available from other supported areas.

Other income

Other funding is important for TIA to enhance its de-risking role as the primary funder of early-stage technology innovation in the National System of Innovation. To increase its funding capacity, TIA pursues strategies to strengthen its funding base, with careful consideration of the constrained fiscal conditions under which it operates. Accordingly, over the period ahead, the agency will continue to focus on creating other income streams to support its programmes and initiatives. This will be done through contract-specific funds from the DSI and other government institutions, and fostering partnerships in the public and private sectors by means of the hub-and-spoke model. Funding from these partnerships is expected to amount to R770 million over the five-year period. In addition, maturing technology development projects are expected to yield returns in the form of royalties, loan repayments and other exits. Through effective working capital management, the agency aims to maximise interest earned on cash reserves, which will be used to fund innovation initiatives.

PART C:
MEASURING PERFORMANCE

1. Institutional performance information

2. Impact statement

Impact statement	Improving the quality of life of all South Africans through innovation.

3. Measuring outcomes

Outcome 1: Commercialised innovations

MTSF priority	Priority 2 (economic transformation and job creation) and priority 3 (education, skills and health)		
Outcome statement	**Outcome indicator**	**Baseline**	**Five-year target**
Commercialised innovations	1.1 Number of technologies commercialised	77	100

Explanation of planned performance over the five-year period

a) Through this outcome, TIA will respond to priority 2 (economic transformation and job creation) and priority 3 (education, skills and health) of government's 2019-2024 Medium-Term Strategic Framework. TIA aims to support the development of technologies linked to the implementation of sectoral master plans, all of which are aimed at promoting industrialisation, localisation and exports. TIA also aims to support the commercialisation of technologies to improve competitiveness. This includes the adoption of information and communications technologies, contributing to an increase in gross domestic product, and stimulating job creation. TIA will also contribute to addressing geographic disparities, rural development, transformation and inclusive development. TIA will contribute to transformation by adopting an approach that promotes the creation of technology-based enterprises owned by black youth, women and people with disabilities.

b) **Enablers**
The following will be critical for TIA to achieve its outcomes:
- Strategic sourcing of high-potential projects through partnerships and the ecosystem approach for collaborative funding.
- Sectoral thematic networks to underpin industry alignment for project sourcing and the promotion of co-funding of projects.

c) **Contribution of outcome to achieving impact**
Commercialising innovations will enable TIA to de-risk the development of technological innovations by leveraging existing and new partnerships. This will, in turn, enable the agency to support and commercialise many innovations that will result in a greater social impact and improve the quality of life of many South Africans.

Outcome 2: Delivering on the Bio-economy Strategy

MTSF priority	Priority 2 (economic transformation and job creation) and priority 3 (education, skills and health)		
Outcome statement	**Outcome indicator**	**Baseline**	**Five-year target**
Stimulating a productive bio-economy through innovation	2.1 Number of bio-based technologies commercialised	New indicator	60
	2.2 Number of bio-based entrepreneurs and organisations accessing high-end science, engineering and technical services	New indicator	600

Explanation of planned performance over the five-year period

a) In terms of this outcome, TIA will primarily contribute to the DSI's commitment to priority 2 (economic transformation and job creation) of government's 2019-2024 Medium-Term Strategic Framework. The agency expects that the metrics will assist in tracking its contribution to the mobilisation of government and business expenditure towards research and development, while creating commercial opportunities that will eventually lead to the transformation of South Africa's economy to a knowledge-based economy. TIA will also support priority 3 (education, skills and health) of government's 2019-2024 Medium-Term Strategic Framework in that it seeks to invest in and support technologies that will address the diagnosis, treatment and management of priority areas of communicable and non-communicable diseases.

b) **Enablers**

The implementation of the Bio-economy Strategy recognises that in addition to identifying strategic focus areas, TIA must also deliver its offerings efficiently and effectively. To this end, several key interventions are planned and will be monitored and tracked within the annual bio-economy work plan:

- **Bio-entrepreneurship:** There is a need to provide post-investment support for TIA's beneficiaries beyond simple project and programme management. Business enterprises require interventions to continuously adjust and validate business models, build appropriate internal capacities, raise further rounds of funding, and access markets, among other activities. TIA will adopt an ecosystem model using its growing network of incubators and accelerators to support this initiative.
- **Adopting a value chain approach to investments:** TIA will take a value chain approach to conducting its investments. This will be a marked departure from the project-by-project approach it has adopted since its establishment. An 80/20 split between targeted calls and unsolicited applications will be adopted. This is also expected to have a positive impact on the long turnaround times for applications.
- **Strategic partnerships and fundraising:** There is a growing need for TIA to maximise its resources to support technology development and commercialisation. TIA will build on its recent partnership success with the creation of the Biotech Fund to attract funding from the private sector. Another opportunity is the roll-out of the Natural Products Fund to coordinate funding from the public sector to support technology-based enterprises. It is also envisaged that the value chain, or programmatic, approach will enhance TIA's chances of attracting industry co-funding and technology-based solutions that address common industry challenges.
- **Historical portfolio alignment:** Significant funding has gone into bio-innovation projects since TIA's establishment. There is a need to align this portfolio with the selected focus areas and retain value and promote the progression of such investments. As such, TIA will create a matchmaking marketplace to promote other funders' uptake of these technologies. TIA will use the initiatives such as the BIO Conventions, Bioportal and Innovation Bridge as mechanisms to achieve this.
- **Communication:** Over the next five years, TIA will adopt a dedicated strategy to communicate with stakeholders to improve its visibility and public engagement. The DSI has selected the agency to host the national bio-economy portal. This initiative is aimed at improving the exchange of information among individuals and organisations in the bio-economy sector; and facilitating communication, improving cohesion, and promoting functional integration and collaboration. The bio-economy portal is envisaged as a user-friendly, integrated and data-rich resource that will

offer quality, valuable data and analytical capacity to all stakeholders. This communication initiative, including TIA's participation in the BIO Conventions, must be consolidated into a coherent strategy of active and consistent engagement with the public, and convey TIA's activities in the Bio-economy programme and other developments in the sector.

c) **Contribution of outcome to achieving impact**
In line with its mandate, TIA must support technology to advance projects towards commercialisation. Accordingly, the agency aims to ensure that its implementation of the Bio-economy Strategy addresses the strategy's ambition for science, technology and innovation to be key contributors to gross domestic product.

Outcome 3: Small, medium and micro enterprises supported through strategically informed and regionally distributed Technology Stations

MTSF priority	Priority 2 (economic transformation and job creation)		
Outcome statement	**Outcome indicator**	**Baseline**	**Five-year target**
Small, medium and micro enterprises supported through strategically informed and regionally distributed Technology Stations	3.1 Number of small, medium and micro enterprises accessing science, engineering and technical services	10 530	15 750

Explanation of planned performance over the five-year period

a) Through this outcome, TIA will contribute to priority 2 (economic transformation and job creation) by investing in new forms of technology development infrastructure in partnership with other role players in the National System of Innovation, and increasing access for innovators across the country to receive science, engineering and technical support. The Technology Stations programme will be closely aligned with relevant industrial sectors to promote innovation-led industrialisation, localisation and the promotion of exports. This will be in line with the sectoral master plans that are under development, led by the Department of Trade, Industry and Competition.

b) **Key enablers**
- Partnership with relevant industry stakeholders.
- Availability of funding through the Infrastructure Fund.

c) **Contribution of outcome to achieving impact**
Technology infrastructure will enable innovators and small, medium and micro enterprises to commercialise their technologies and improve the competitiveness of their products, leading to job creation and localised economic growth.

4. Key risks

TIA employs a robust, systematic process at the operational and strategic levels, which is integrated and central to its strategic planning process. The applied methodology is derived from the prescripts of the Committee of Sponsoring Organisations' Enterprise Risk Management Framework, ISO 31000 on Risk Management, National Treasury's Public Sector Risk Management Framework, the Institute of Risk Management South Africa's risk principles, and TIA's Risk Management Policy.

A review of the risk landscape will be undertaken once the priorities for the DSI's Decadal Plan, government's 2019-2024 Medium-Term Strategic Framework, the five-year Bio-economy work plan and the five-year Technology Stations Programme work plan are approved. A review was undertaken to determine the emerging risk profile, the results of which

were tabled and approved at the Enterprise Risk Management Committee, Executive Committee and the Audit and Risk Committee, which are outlined in Table 4.

Table 4. Strategic risk and mitigation plans for 2020-2025

Outcome	Key risk	Risk mitigation
1. A sound governance administration	The risk that TIA cybersecurity systems might fail due to enhanced cyber-attacks on current operating system vulnerabilities	Increased monitoring of information technology system vulnerabilities through enhanced automated system assessment
	The risk that TIA's governance practices may not be adequate in detecting and preventing instances of fraud, bribery and corruption	Strengthen internal control policies and processes for regulating contracting with third parties
	The risk that the TIA management does not have the capability to deliver on the strategy	Managed implementation of the organisational realignment through phased adoption based on planned performance requirements over the strategic cycle
2. A sustainable Bio-economy Strategy	The risk that TIA's demand for technology development funding emanating from the investment pipeline may exceed available funding resources available	Mobilisation of funding through strategic partnerships with key public and private institutions, locally and internationally
	The risk that TIA's investment and administrative operations may not effectively be addressing environmental sustainability considerations in relation to the pursuance of its strategic objectives	Formulation of appropriate policies and controls to ensure that considerations into the impact on the environment are observed
3. Sustainable Innovation infrastructure	The risk of the affordability and sustainability of infrastructure Cost of preventative maintenance and replacement of old and redundant equipment	Regular health checks done on all infrastructure
4. Successfully bridging the innovation chasm	Lack of adequate, knowledgeable and skilled resources to execute this planned outcome (lack of commercialisation skills)	Targeted recruitment and headhunting
	Unable to form strong partnerships due to TIA's reputation	Drastically improve stakeholder relations

PART D:
TECHNICAL INDICATOR DESCRIPTIONS

Outcome 1: Commercialised innovations

Indicator title	1.1 Number of technologies commercialised
Definition	Number of technological innovations that have been introduced into the market for social benefit or commercial gain, directly or indirectly (products, processes or services)
Source of data	Programme/project database(s)
Method of calculation/ assessment	Simple count
Assumptions	Innovation outputs will be developed successfully to a point where there is a market or social demand
Disaggregation of beneficiaries	Women (30%) Youth (20%) People with disabilities (10%)
Spatial transformation (District Development Model)	To be informed by and aligned with the priorities of government's 2019-2024 Medium-Term Strategic Framework, as guided by the DSI
Reporting cycle	Annual
Desired performance	Performance equal to or greater than planned target Achievement of 90% of the target will be deemed acceptable
Indicator responsibility	General Manager: Sector Funding General Manager: Programmes

Outcome 2: Delivering on the Bio-economy Strategy

Indicator title	2.1 Number of bio-based technologies commercialised
Definition	Number of bio-based technological innovations that have been introduced into the market for social benefit or commercial gain, directly or indirectly (products, processes or services)
Source of data	Programme/project database(s)
Method of calculation/ assessment	Simple count
Assumptions	Innovation outputs will be developed successfully to a point where there is a market or social demand
Disaggregation of beneficiaries	Women (30%) Youth (20%) People with disabilities (10%)
Spatial transformation (district development model)	To be informed by and aligned with the priorities of government's 2019-2024 Medium-Term Strategic Framework, as guided by the DSI
Reporting cycle	Annual
Desired performance	Performance equal to or greater than planned target Achievement of 90% of the target will be deemed acceptable
Indicator responsibility	General Manager: Bio-economy

Indicator title	2.2 Number of bio-based entrepreneurs and organisations accessing high-end science, engineering and technical services
Definition	Bio-based entrepreneurs and organisations accessing high-end science, engineering and technical support for the purposes of developing innovative, bio-based products or services through the financial or non-financial support of the Technology Platforms network
Source of data	Programme/project database(s)
Method of calculation/ assessment	Simple count
Assumptions	Adequate numbers of bio-based entrepreneurs and organisations will be interested in the services offered The Technology Platforms possess adequate expertise and have access to adequate funding to provide and maintain infrastructure required for science, engineering and technical support
Disaggregation of beneficiaries	Historically disadvantaged individuals (80%) Women (45%) Youth (40%) People with disabilities (3%)
Spatial transformation (district development model)	To be informed by and aligned with the priorities of government's 2019-2024 Medium-Term Strategic Framework, as guided by the DSI
Reporting cycle	Annual
Desired performance	Performance equal to or greater than planned target Achievement of 90% of the target will be deemed acceptable
Indicator responsibility	General Manager: Bio-economy

Outcome 3: Small, medium and micro enterprises supported through strategically informed and regionally distributed Technology Stations

Indicator title	3.1 Number of small, medium and micro enterprises accessing science, engineering and technical services
Definition	Small, medium and micro enterprises that access science, engineering and technical support for the purposes of developing innovative products or services through the financial or non-financial support of the Technology Stations network
Source of data	Programme/project database(s)
Method of calculation/ assessment	Simple count
Assumptions	An adequate number of small, medium and micro enterprises will be interested in the services offered Technology Stations possess adequate expertise and have access to adequate funding to provide and maintain infrastructure required for science, engineering and technical support
Disaggregation of beneficiaries	Historically disadvantaged individuals (80%) Women (45%) Youth (40%) People with disabilities (3%)
Spatial transformation (district development model)	To be informed by and aligned with the priorities of government's 2019-2024 Medium-Term Strategic Framework, as guided by the DSI
Reporting cycle	Annual
Desired performance	Performance equal to or greater than planned target Achievement of 90% of the target will be deemed acceptable
Indicator responsibility	General Manager: Programmes

Notes

Notes

GAUTENG HEAD OFFICE
+27 (0) 12 427 2700

Postal Address
P.O. Box 172
Menlyn
Pretoria
0181

Physical Address
TIA House
83 Lois Avenue
Menlyn
Pretoria

KWAZULU-NATAL OFFICE
+27 (0) 31 220 3101

Postal Address
P.O. Box 30603
Mayville
Durban
4058

Physical Address
4th Floor
102 Stephen Dlamini Road
Musgrave
Durban

WESTERN CAPE OFFICE
+27 (0) 21 442 3780

Postal Address
P.O. Box 13372
Mowbray
Cape Town
7705

Physical Address
4th Floor, Central Park
Black River Business Park
Fir Road, Observatory
Cape Town

www.tia.org.za

@tiaorgza tiaorgza www.linkedin.com/company/technology-innovation-agency

technology innovation
AGENCY
Innovating Tomorrow Together